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REPORT ON AN INQUIRY INTO THE QUALITY OF FARM SEEDS—1912-1914.

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DURING the years 1912, 1913, and 1914 samples of the commoner kinds of clover and grass seeds offered for sale in various parts of the country were collected by the Board's inspectors, and subsequently examined at Cambridge, on behalf of the Board, in order to determine their purity and germinating capacity. These samples were obtained from all kinds of dealers in seeds, from the large merchants who handle nothing but agricultural seeds down to village tradesmen whose sales of seeds form but a small proportion of their total miscellaneous dealings. In each year a few samples were also obtained directly from farmers interested in the inquiry. The number of samples examined in detail was 676, and in addition partial analyses were made of a small number of samples (49) of mixed grasses and clovers.

In 1912, 208 samples were obtained from all parts of the country, mainly, however, from the Eastern and Southern Counties. In 1913, 295 samples were collected in the Midlands and South-Midland Counties, the West of England and North Wales, and in 1914 the inquiry was limited to the three Ridings of Yorkshire, in which 173 samples were collected.

The total number of samples is perhaps too small to provide more than an approximate survey of the supply available to farmers purchasing their seeds locally, but taking the three years together the averaged results probably reflect the state of affairs throughout the country with sufficient accuracy. Whether this is the case or not, the broad facts emerging from an analysis of the results are obvious and indisputable.

These results show that, though seeds of the highest quality can be purchased, much of the seed offered for sale is of indifferent quality, whilst some of it is excessively bad from all points of view. They also show that when ordering home-grown seed the purchaser cannot count upon receiving it, for foreign seed is frequently substituted for it wholly or in part. Other forms of adulteration, however, are rare. Further, the art of "faking," whereby the natural appearance of the seed is altered, generally to obliterate symptoms associated with age, is not altogether extinct. The evidence for these statements and other facts brought out are given below in a series of notes dealing with each of the kinds of seed examined.

The results of the analyses are summarised in Table I., showing the average "real value" for the more important agricultural seeds in each of the years 1912, 1913, and 1914. The percentage of real value is obtained by multiplying together the percentage of purity and the percentage of seeds capable of germination and dividing the result by 100. For example, if the purity of a sample of red clover is 96 per cent., and its germinating capacity 92 per cent., the real value is $\frac{96\times92}{100}$, or 88·3 per cent. The figures for all the samples of any given kind are averaged together. Thus, under the heading of English or Welsh red clover for the year 1912 the real value, calculated from 56 samples, was 67·3 per cent. Or, putting the matter in a more practical way, the figures show that a purchaser of 100 lb. of this average red clover seed would only obtain about 67¼ lb. of *useful seed*, the remainder con-

TABLE I.

Average Real Value per cent.

(The figures in brackets refer to the number of samples examined.)

Seed.	*1912.*	*1913.*	*1914.*
Red Clover	67·3 (56)	58·1 (42)	55·9 (30)
White Clover	50·6 (31)	61·3 (30)	56·9 (45)
Alsike	54·5 (29)	58·1 (21)	62·5 (25)
Cowgrass	..	68·8 (17)	72·7 (24)
Trefoil	..	67·9 (15)	..
Sainfoin	45·8 (10)	35·5 (29)	..
Italian Rye Grass ..	79·2 (37)	72·5 (24)	..
Perennial Rye Grass ..	72·5 (23)	71·8 (23)	..
Cocksfoot	..	66·0 (16)	63·1 (20)
Meadow Foxtail ..	..	46·9 (15)	51·4 (13)
Timothy	..	92·6 (13)	..
Mangold	116·4 (20)	..	116·7 (22)

sisting of 32¾ lb. of dead seeds, weed seeds and rubbish. Stating the results by averages only, masks the fact that there is a wide range of difference between the good and bad samples. Some idea of the differences is given in Table II., which shows the highest and lowest values of the germinating capacity of each kind of seed dealt with in the course of the inquiry. Further information is given in the notes dealing with the general results of the analyses.

TABLE II.

Highest and Lowest Percentage of Germination.

Seed.	*1912.*	*1913.*	*1914.*
Red Clover	95 — 2	92·3— 0·3	93·6— 0
White Clover	91 — 0·6	98·6— 4·6	93·6— 2·3
Alsike	80 —25	98 — 0·6	88 — 1
Cowgrass	..	91·6— 3	95·6—46·2
Trefoil	..	92 —14	..
Sainfoin	75 — 3	89 — 0	..
Italian Rye Grass ..	97 —62	91 —46	..
Perennial Rye Grass ..	94 — 3	91 —46	..
Cocksfoot	..	90 —44	92 —22
Meadow Foxtail ..	..	81·9— 0	88 — 8
Timothy	..	99 —90·3	..
Mangold*	191 —52	..	165 —49

* Seeds germinating in 100 fruits.

No attempt has been made to compare the percentages of *purity* of the different kinds of seeds, for a mere tabulation of the results in a manner similar to those for the germinating capacity would be misleading. The impurities present in seeds fall into two classes: (1) *harmless impurities*, such as chaff and grit, and (2) *harmful impurities*, such as weed seeds or even seeds of a different kind deliberately added with a view of increasing the vendors' profits. By way of example, the purity of a sample of meadow foxtail may be compared with the purity of a sample of red clover. The value for the purest sample of the former met with during the inquiry was 89·4 per cent., and several samples of red clover had approximately the same percentage of purity. In the case of the foxtail the impurity consisted almost entirely of chaff, which is particularly difficult to separate from the perfect seeds. The only complication to which its presence leads is the small one of making an allowance for it in order to secure the correct amount of pure seed in compounding a mixture for permanent pasture. Sowing such seed leads to no harmful result. In the case of the red clover, however, the same amount of impurity is a serious matter, for the

10·6 per cent. of waste matter consists of weed seeds, of which, for the moment, mention need only be made of docks and clover dodder. In place of a table of the percentages of purity a short account of the impurities most commonly met with, and occasionally an indication of their prevalence, are given in the general notes dealing with each kind of seed examined.

Records of the prices asked for each lot of seed sampled were made throughout the inquiry. With some outstanding exceptions, these records show that the higher-priced lots were superior to those for which lower prices were asked. Nevertheless, some utterly valueless samples were met with for which average prices had been demanded. Where the question of price is of special interest the average value has been determined for the year 1913 for comparison with the prices quoted for the best value then obtainable. In this connection it should be remembered that in 1913 the prices for clover seeds of various kinds were above the usual average owing to the unfavourable conditions obtaining during the growing and harvesting time in 1912, whilst grass seed, much of which is produced abroad, was about the average price of previous years.

Red Clover.—The 128 samples investigated were all purchased under the description of English or Welsh-grown red clover. Nevertheless 33 of them contained the seeds of plants which do not occur in the wild state in this country, but are characteristic weeds of the clover crop in Chile, Canada, France and Russia. Their presence points to the fact that foreign-grown seed had been either wholly substituted for the home-grown, or that stocks of the latter had been eked out by the addition of imported seed. The commonest adulterant was Chilian red clover. This can usually be detected with ease on account of the fact that it generally contains quantities of the seeds of a local clover dodder. These are of approximately the same size as the seeds of the clover itself, and although the majority of them can be removed by the use of suitable cleaning machinery a few generally remain to indicate the country of origin of the seed.

The low average value (67·3, 58·1 and 55·9) of these clover samples was due, in the main, to the fact that many, probably the majority, of the samples consisted of mixtures of seeds of various years' growth. A good clover sample of the current season's growth consists mainly of seeds ranging in colour from shades of lemon-yellow, yellowish-grey and slate colour to purple. It may, particularly if somewhat unripe, contain a few

smaller, partially-shrivelled brown seeds. If such a sample is stored the colours tend to become more uniform, and in a few years' time all of the seeds take on a characteristic foxy-brown colour. If then full-sized brown seeds are present one may suspect that part of the sample, if not all, consists of old seeds. Their presence was characteristic of many of the samples examined, and wherever they were numerous there was a proportionately low germinating capacity when the samples were tested. In one, indeed, which must have been of some respectable antiquity, not a single seed was capable of germinating. On the other hand, several of the freshly-coloured samples reached the passable figure of 95 per cent. for germinating capacity. The difference in the appearance of good and bad samples is so striking that it is difficult to understand why seeds, which obviously will not grow, are ever purchased.

The impurities present on the average amounted to 6 per cent. In the best samples only the merest traces of impurities could be detected, whilst the worst single sample contained 21 per cent. These impurities consisted mainly of weed seeds, fragments of grit, and the debris of clover plants, such as fragments of stems and of clover pods. The commonest weed-seeds present were those of the plantain, campion, geranium, dock, and clover dodder. Those of plants not natives of our own flora are for the time being neglected, as they mostly fail to establish themselves in this country. This fact is worth noting, for it raises the question whether the clover itself, from countries with climatic and soil conditions very unlike those obtaining in Britain, is likely to prove as suitable for British cultivation as the seed of English-grown crops.

In the opinion of the writer the seeds of plantains, campion, and geranium are only serious impurities where the clover is grown for seed. They take the place of clover plants it is true, but even if they seed themselves freely, the resulting plants are easily eradicated in the ordinary course of farming. This, however, is not true in the case of docks, for though the cutting of the crop prevents the formation of mature seeds, a vigorous perennial root is left in the soil. The subsequent ploughing in of the crop does little more than temporarily disturb it, leaving it, unless hand-pulled, to develop a crop of seeds in the following wheat crop. Viewed from a practical standpoint the presence of only 1 per cent. of dock-seed in an otherwise pure sample of clover should be sufficient to condemn it. It means that in every pound of red clover seed purchased there are some 3,200

dock seeds,* and if the clover is sown at the rate of 16 lb. per acre no fewer than eleven dock seeds are distributed over every square yard.

The occurrence of the seeds of clover dodder is still more serious. No fewer than 76 of the 128 samples of red clover (or 59·3 per cent.) contained the seeds of this pest; 33 of the samples contained Chilian dodder seeds, and of these 18 contained European dodder seed as well. Yet the seed itself is so small that it can easily be screened out of the much larger seeds of red clover without entailing an appreciable loss of good seed. Samples containing even the merest trace of clover dodder seeds, even the infinitesimal quantity of one seed per pound, should invariably be rejected, for once this plant becomes established it is only eradicated with excessive difficulty. Not only does it kill off considerable areas of the current crop, but the crop succeeding at intervals of four or even eight years may also be attacked. This subsequent infection may be brought about by dormant seeds or by the plants tiding over each season by developing on other hosts, such as thistles.

The occurrence of the seeds of Chilian clover dodder is less serious. In the Northern Counties it is said that the parasite entirely fails to establish itself, whilst in the South serious outbreaks of the pest do not appear to be at all general.

The prices for red clover seed collected during 1913 varied from 10*d.* to 1*s.* 8*d.* per lb., and averaged 1*s.* 1*d.* The average real value was 58·1 per cent., yet during this year (1913) seed could be obtained of a guaranteed real value of 98 per cent., at a cost of 1*s.* 3*d.* per lb.!

Cowgrass.— Forty-one samples sold as cowgrass were collected in 1913 and 1914. In general characteristics they were so similar to those of red clover that no detailed account is necessary. Dodder seed occurred in 18 of the samples. In 6 samples the dodder was the Chilian species, in one both Chilian and European, and in the remaining 11 European only.

Prices ranged from 8*d.* to 1*s.* 6*d.* per lb. in 1913, and averaged 1*s.* 2½*d.* for an average real value of 68·8 per cent. The best value obtainable on the market at this time was seed with a guaranteed real value of 98 per cent. at 1*s.* 9*d.* per lb.

White Clover.—The average real values for the seasons 1912-14 were 50·6, 61·3, and 56·9 respectively. The best sample had a germinating capacity of 98·6 per cent., and a purity of 99·6

* *Journ. Board of Agric.*, Vol. XXI, p. 1103, March, 1915.

per cent. whilst the corresponding figures for the worst sample were 4·6 per cent. and 25·4 per cent. respectively. Taking the samples as a whole, the purity was fairly satisfactory, except in one respect, viz., the extraordinary prevalence of clover dodder. In 1912 18 samples out of 31, in 1913 8 out of 30, and in 1914 12 out of 45 contained the seeds of this parasitic plant. Apart from this the commonest weedseeds present were chickweed, forget-me-not, sheep's sorrel, field madder, field pansy, plantain, and mayweed.

The low figures for real value were partly to be accounted for, as in the case of red clover, by the prevalence of old seed which had lost its vitality. A sample of the current year's growth is composed of polished seeds varying in colour from a vivid lemon-yellow to bright orange-brown, whereas samples containing old seed can readily be recognised by their dull appearance and the rusty brown seeds they contain. Some samples, *e.g.*, the one mentioned above with a germinating capacity of only 4·6 per cent., consisted of nothing but old seed (possibly harvested 9 or 10 years previously), whilst others were old seed brightened up by admixture with some of more recent growth.

At the same time, part of the deficiency in the germination figures was due to the presence of considerable percentages of "hard seeds." Samples containing from 10 to 12 per cent. were not infrequent; and one occurred in which the percentage was almost 20. These seeds, though living, fail to germinate immediately owing to the fact that their seed coats are almost impervious to water. If sown, they may lie dormant in the soil till the following season, or even later, and then germinate. From the point of view of crop-production they are consequently of little, if any, more value than dead seeds. Fortunately, methods of rendering the seed coats pervious to water have been discovered, and nowadays several seed firms can supply seed with a guaranteed germinating capacity of 98 per cent.

One case of deliberate adulteration was met with in 1913, seed of a worthless annual clover known as *Trifolium parviflorum** having been mixed with somewhat old seeds of white clover, presumably to give the sample a more attractive appearance. This species can be purchased cheaply from certain Continental seedsmen, and consequently it is as well to look out for its presence when white clover seeds are purchased from dealers in whom one has not complete trust. The seeds are slightly smaller

* See also *Journal*, Vol. XVIII., July, 1911, p. 323.

than those of white clover, and they are either lemon-yellow, orange-brown, or black in colour. Consequently, if black seeds occur in a sample, one may reasonably be suspicious. Careful examination with a magnifying glass will settle the matter once for all, for the seed of *Trifolium parviflorum* has a rough seed coat, whilst that of the true white clover is perfectly smooth.

The prices in 1913 ranged from 10*d*. to 2*s*. 6*d*. per lb., the average for the series collected being 1*s*. 5*d*. per lb. Real values showed a range of 0·6 per cent. to 97 per cent. Yet seed with a purity of 100 per cent., and a guaranteed germination of 98 per cent., could be purchased for 2*s*. per lb.

Alsike.—The results of the analyses of alsike were very similar to those of white clover. Some excellent samples with a germinating capacity of over 98 per cent. were met with, the majority were moderately good, and in each season there were a few excessively bad ones. *The worst, with a germinating capacity of only 0·6 per cent., was obviously many years old, but nevertheless it was offered for sale at 1s. 4d. per lb.* The low figures for the real value percentage (Table I.) are accounted for partly by the age of the seed and partly by the frequency of "hard seeds." These averaged some 10 per cent., whilst in extreme cases 20 to 25 per cent. were present.

The most unsatisfactory feature of the samples, as in the case of the clovers previously described, was the extraordinary prevalence of dodder seeds. Again there is no excuse for it, for though the seeds of alsike are small, those of European dodder (the only dodder present in this case) are still smaller and removable with certainty by the employment of suitable sieves.

Table III. shows at a glance how serious is the state of affairs as regards dodder. The total number of samples examined each year is placed in brackets, and immediately in front of it the number found to contain dodder seeds. The sum total shows that they amount to 167 of the 350 samples tested.

TABLE III.

Seed.	*1912.*	*1913.*	*1914.*	*Total.*
Red Clover	30 (56)	28 (42)	18 (30)	76 (128)
Cowgrass	..	9 (17)	9 (24)	18 (41)
White Clover	18 (31)	8 (30)	12 (45)	38 (106)
Alsike	19 (29)	8 (21)	8 (25)	35 (75)
Total	67 (116)	53 (110)	47 (124)	167 (350)

These seeds are almost invariably sown in the same condition as purchased, so that it would appear that practically half of the land put down to clover each year runs the risk of becoming infected with clover dodder.

For the year 1913, prices of alsike varied from 1*s.* to 1*s.* 6*d.* per lb., and averaged 1*s.* 3*d.* The range of the percentage of real value was the same as that of white clover, namely, 0·6 to 97 per cent. Pure seed, with a guaranteed germination of 98 per cent., was quoted during the year at 1*s.* 6*d.* per lb.

Sainfoin.—Thirty-nine samples, some milled and some in the husk, were collected in 1912 and 1913. The purity throughout was excellent, ranging from 96 to 100 per cent. The result, however, is not typical, for whilst milled seed is almost invariably pure, that in the husk is often badly contaminated with the seed of burnet.

The germinating capacity, on the other hand, was far from satisfactory. The best sample of the whole series showed a germinating capacity of 89 per cent., the average was 38 per cent., there were several below 10 per cent., and one in which every seed was dead.

The presence of "hard seeds," amounting to about 12 per cent. on the average, accounts to a certain extent for the deficiencies in the germinating capacity, but the main cause was to be found in the age of the seed. Taking the whole set together, half of the seeds (100 per cent., less 38 + 12 per cent.) had perished during the five years they had been in store. A noteworthy feature of the germination tests was the difference between milled seed and that in the husk, the milled seed being distinctly inferior in this respect.

Trefoil.—Fifteen samples of this seed were collected in 1913. Their germinating capacity varied from 14 to 92 per cent., whilst the real value averaged 67·9 per cent. Prices ranged from 6*d.* to 1*s.* 6*d.* and averaged 11½*d.* per lb. The cheapest samples at 6*d.* and 8*d.* per lb., whilst reasonably free from impurity, were very deficient in their germinating capacity, which only amounted to 14 or 15 per cent.

Mangold.—The real value for the seeds of mangold during the two years in which it was tested averaged 116·4 and 116·7. In this case the real value is the same as the germinating capacity, since the samples had a purity of 100 per cent. The extreme values were 191 and 49.

The results, though far from the best obtainable, cannot be considered bad, for, at ordinary rates of sowing, seed of an average real value of 116 would provide a full plant. Further, as far as can be gathered from germination trials, the seeds were very true to type.

Prices in 1912 ranged from 8*d.* to 1*s.* 8*d.* per lb., and averaged 1*s.* 2*d.* per lb., whilst in 1914 the average price was 10*d.* and the extremes were 6*d.* and 1*s.* 1*d.* The prices proved a poor index to the actual value of the seed, for the cheapest samples were by no means the worst. In fact the single sample of seed offered at 6*d.* per lb. had a germinating capacity of 130 per cent., or 14 per cent. over the average for the two seasons.

Grass Seeds.

The grass seeds proved to be better than those of the various clovers. Samples of cocksfoot, foxtail and Italian and perennial rye grass were obtained in 2 years and Timothy grass in 1 year only. In addition, one or two samples were taken of sheep's fescue, hard fescue, meadow fescue, tall fescue and crested dogstail.

Italian Rye Grass.—The 37 samples of the 1912 series had a real value of 79·2 per cent., and the 24 samples collected in 1913 of 72·5 per cent. Several of the samples showed over 90 per cent. germination, whilst the purity occasionally reached 100 per cent., the lowest value for purity being 65 per cent. The extreme figures for the germinating capacity were 97 and 46 per cent.

When the fact is taken into consideration that empty seeds, or chaff, are reckoned as an impurity, the average value for the purity (93 per cent.) was satisfactory. Apart from chaff the main impurities were seeds of soft brome grass and, more rarely, of Yorkshire fog.

The prices, ranging from 4*d.* to 8*d.* per lb., corresponded approximately with the real value of the samples. In 1913 pure seed with a guaranteed germination of 97 per cent. was obtainable at 35*s.* per cwt., or $3\frac{3}{4}$*d.* per lb.

Perennial Rye Grass.—The results of the analyses of 46 samples of this species were very similar to those of the Italian rye grass. The real value was slightly lower, averaging 72·5 and 71·8 per cent. respectively in 1912 and 1913, owing to a slightly lower average value for the germinating capacity.

Four samples sold as perennial rye grass consisted of Italian rye grass, and in one case the sample was a mixture of the two species.

The usual price quoted was 4*d.* per lb. In 1913 the best quality, with a bushel weight of 28 lb. and a guaranteed germinating capacity of 97 per cwt., was obtainable at 28*s.* per cwt., or in smaller quantities at $3\frac{1}{4}$*d.* per lb.

Cocksfoot.—The 16 samples taken in 1913, and 20 in 1914, had average real values of 66·0 and 63·1 per cent. respectively, whilst

the germinating capacity ranged from 22—92 per cent. The purity of the samples was satisfactory, since practically all of the impurity present consisted of small quantities of empty seeds. The one serious fault to be found was with the age of some of the samples. Freshly harvested seed should germinate over 90 per cent., and whilst this figure was reached fairly frequently, many of the samples gave a value of only 60—70 per cent.

In 1913, the prices quoted for the cocksfoot seed sampled ranged from 8*d.* to 1*s.* 4*d.* per lb., with an average value of 11*d.* per lb. At the same time cocksfoot seed with a guaranteed germination of 95 per cent. was obtainable at 1*s.* per lb.

Foxtail. —The real values for 15 samples collected in 1913 and 13 in 1914 worked out at 46·9 and 51·4 per cent. The result, at first sight, is unsatisfactory, but in reality it is better than anticipated. This is due to the fact that most of the machinery used for cleaning this seed fails to make even an approximately complete separation of the empty from the seed-filled chaff. As the empty chaff constitutes an impurity the values for purity are generally considerably below those of other agricultural seeds. The highest value was 89·4 per cent., and the lowest 7·9, chaff in each case constituting practically the whole of the impurities. The germination of this seed is also often faulty, and consequently the fact that half of the samples reached as high a value as 80 per cent. was distinctly satisfactory. The germinating capacity ranged from 0 per cent. to 88 per cent.

The prices for the various lots sampled varied from 8*d.* to 2*s* per lb., and averaged 1*s.* 3*d.* In 1913 seed with a germinating capacity of 85 per cent. was priced at 1*s.* 4*d.*, but the only indication given of its purity was a statement of the bushel weight. This amounted to 14 lb., a figure only obtainable with highly-cleaned seed.

No other set of samples shows as clearly as that of foxtail the value of testing samples of seeds before purchasing in quantity. Judging from the prices asked, one would have considered a sample offered at 8*d.* per lb., when the average cost was practically twice as great, to be more or less worthless. In this case, however, one of these, the cheapest of the samples, gave on analysis a germinating capacity of 80 per cent., a chaff content of 24 per cent., and purity 74 per cent., or real value 59·2 per cent. On the other hand, a sample priced at 1*s.* 2*d.* per lb. might be expected to show better results, yet one such sample was found on analysis to consist of 84 per cent. chaff, 7·9 per cent. of pure seeds, and 8 per cent. of other seeds, such as York-

shire fog, soft brome, hair grass, and cocksfoot. The germinating capacity of the pure seed after a month's trial was nil.

Timothy.—Thirteen samples of the seeds of this grass were examined in 1913. The seed is generally of a high degree of purity, and the germinating capacity of samples of recent origin rarely falls below 90 per cent. The average real value for all of the samples was 92·6 per cent., whilst the germinating capacity varied from 90·3 to 99 per cent. The results are entirely satisfactory.

Other Grass Seeds.—Of the other grass seeds examined little can be said. The samples were too few to be representative, and were species which are not usually stocked by the smaller dealers. They are used in relatively small quantities for the preparation of grass seed mixtures intended for the most part to occupy the land for at least three years, and sometimes for an indefinite period. They included wood meadow grass, crested dogstail, sheep's fescue, meadow fescue, hard fescue, and tall fescue. The results of the analyses were, on the whole, good.

Seed Mixtures.—Further analyses bearing on the supply of grass seeds ordinarily available were made of samples of mixed seeds, sent for the most part by farmers directly to the Board of Agriculture and Fisheries. These consisted of 8 samples intended for a one year ley, and 29 for temporary, and 12 for permanent pastures. In some cases the purchasers had drawn up their own prescription for the required mixture, and in others had left it to the discretion of the vendors, merely stipulating the prices they were prepared to pay per acre.

Each mixture was separated out into its component species, and where practicable the amounts of the various seeds present were compared with the amounts ordered. Estimates were also made of the percentage of weed seeds present. The average quantity of impurity present, including chaff, worked out at 3·7 per cent. The impurities were for the most part harmless, with the exception of clover dodder, which occurred in 10 of the 49 samples examined. In one of the samples *Trifolium parviflorum* was present to the extent of 2 per cent. With one exception the mixtures were suitable for the purposes for which they were wanted. The exception was a mixture containing 19·5 per cent. of useful species, 7·5 per cent. of sand and grit, and the remaining 73 per cent. weed seeds and chaff. It was probably nothing more than the sweepings of a hay-loft.

General Conclusions.—The results of the inquiry show clearly that whilst abundant supplies of agricultural seeds of the highest

quality are obtainable, there is still a considerable market for seeds of a far lower grade, and even for seed which cannot possibly yield a satisfactory crop. Further, as a comparison of the prices will show, seed of the best quality does not, as a rule, cost much more per pound than the average price as determined for each of the kinds dealt with. Under these circumstances, it seems extraordinary that seeds which are often obviously bad should ever be purchased.

The reasons often given for buying the poorer grades of seeds are worth examining in some detail. Perhaps the commonest is that cheap seeds are good enough for the land on which they are to be sown, the implication being that the land is so foul that a few extra weeds do not matter. Whilst one recognises that some land is certainly difficult to keep reasonably clean, there is no reason why the matter should be made still more difficult and the yield of subsequent crops curtailed by the growth of an additional crop of weeds. The 4 or 5 per cent. of weed seeds frequently occurring in the samples of white clover or of alsike made singularly little difference to their general appearance, but an admixture on this scale might well be responsible for sowing as many as 50 weed seeds on every square yard of a field. Even if only one-half germinated, and if one-half the resulting plants were crowded out of existence by the clovers, there is a notable addition to the weed-content of the land. Moreover, if the cleaning processes to which the bulk of the seed has been subjected have been carried out so inadequately it is, in the case of the clovers, very probable that many of the seeds of the parasitic clover dodder remain from which the crop may suffer considerably.

The same argument does not apply so strongly in the case of the majority of the grass seeds, since the impurities are mainly empty seeds and fragments of flowering stems. Even here, however, the better germinating capacity of the highest grade samples makes their employment more economical.

Another reason frequently given for the use of poor seeds is that seeds of the best quality are too expensive for sowing for the production of ordinary crops, however suitable they may be for the production of further seed crops. In the majority of cases the reasoning is false, and the truest economy is to purchase the best seed obtainable. The fact may be illustrated by comparing the relative values of the average red clover samples examined in 1913 and a pure sample. The prices were 1*s.* 1*d.* and 1*s.* 3*d.* per lb. respectively, the real value of the former being 58·1 per

cent., and of the latter 100 per cent.* In the *best sample* there were some 215,000 germinable clover seeds per lb., so that each penny purchased $\frac{215,000}{15}$, or 14,333 "good" seeds. The *average sample* contained some $\frac{215,000 \times 58{\cdot}1}{100}$, or 124,915 germinable clover seeds per lb., and hence 1*d.* purchased only $\frac{124,915}{13}$, or 9,609 "good" seeds. The expenditure of an extra 2*d.* per lb. therefore gave an additional 14,333—9,609, or 4,724 seeds for every 1*d.* expended.

Thus, economy is secured by the fact that a lower seeding-rate per acre can safely be used if the best quality of seeds are sown. Thus, assuming that 10 lb. of the *best quality, i.e.*, 2,150,000 seeds are sufficient per acre, the cost would be 12*s.* 6*d.* To sow a similar quantity of the *average seeds* would require $\frac{2,150,000}{124,915}$ or, roughly, 17 lb. of seed costing 18*s.* 5*d.*

This is by no means an extreme case, for some of the worst samples of red clover had so low a percentage of real value that a seed-rate amounting to over one ton per acre would have been necessary to secure sufficient clover seeds to provide a full plant!

From the data obtained from the analyses similar examples could be multiplied almost indefinitely. Without considering others, however, the general statement may be made that the higher-priced samples, especially if offered under a guarantee of germinating capacity, usually contained a larger number of germinable seeds per lb. than those sold at lower prices. Apart altogether from this, the samples which at first sight seemed the most expensive usually had the advantage that they were comparatively free from weed-seeds and other impurities, except in the case of such seeds as mangold or milled sainfoin, which usually have a purity of 100 per cent.

Reviewing the results of the 676 analyses as a whole *the relative cheapness of the guaranteed seeds as compared with the average of those collected indiscriminately from all kinds of dealers is perhaps the most noteworthy fact.* As already indicated, a few exceptions occurred and bargains could be found here and there, though these were not bargains the ordinary purchaser could pick up, for an analysis was necessary before their value became evident. Moreover, they were so rarely met with that their existence offers no prospect of finding them without devoting far more attention to searching for them than the saving in price would warrant.

* This sample did not occur amongst those collected by the Board's Inspectors. It was purchased as pure and with a guaranteed germination of 98 per cent. The analyses showed a purity of 100 per cent. and a germinating capacity of 100 per cent.

SEED TESTING, AND THE NEED FOR DESTROYING WEEDS.

Seed Testing.—The preceding article, by Professor Biffen, shows only too clearly the need which still exists for farmers to exercise the greatest possible care in purchasing their seeds. The Board desire to impress upon farmers the great importance at the present time of taking steps to ensure that there shall be no failure of crops due to the sowing of poor seed. An article dealing with "Seed Testing for Farmers" was published in this *Journal* for March, 1915, p. 1098, and a leaflet (Special Leaflet No. 24, *Seed Testing*) was subsequently issued, indicating to farmers that it is worth their while to make certain that the seeds they sow are good.

Cases showing the kind of loss which may occur are quoted in the leaflet, but an example may be given here. A Herefordshire farmer last year seeded down a field with red clover. In the autumn he discovered that the parasitic weed dodder* was overrunning the field, and the probability is that the field will have to be ploughed up and reseeded. This is both a disappointment and a loss which could easily have been avoided, free of cost, by submitting a sample to the County Agricultural Organiser for examination before accepting and using the seed. Nevertheless, though the importance of ascertaining that the seeds bought are suitable for sowing is generally recognised, all too few farmers submit samples to the Agricultural Colleges and County Agricultural Organisers for examination and report.

At the East Anglian Institute of Agriculture, Chelmsford, the plan has been adopted, in making a seed report, of stating the number of weeds per acre or square yard which might grow on sowing the clover or grass seeds examined. Thus, a clover seed sample might be reported on as follows:—

Clover Seed. Sample 14. Weed Analysis.

Total Weight.	Dock.	Plantain.	Lychnis.	Wild Carrot.
10 grammes	6	161	2	1
1,000 ,, ...	600	16,100	200	100
6 kilogrammes	3,600	96,600	1,200	600
or 13·2 lb.	,,	,,	,,	,,

"If 13·2 lb. of this seed be sown per acre the weeds which will spring up over the field as a result will be: Plantain, 20 plants per sq. yd.; dock, 3 plants on every 4 sq. yd.; lychnis, 1 plant on every 4 sq. yd."

* See Leaflet No. 180 (*Dodder*).

Such figures possibly show even more clearly than the percentage of purity would do the extent to which fields may become infested by sowing seeds containing weed seeds. The percentage of purity in the case quoted was about 97, and might suggest a high-class red clover seed. The weed figures, however, show that it is not so good as it appears.

Apart from the direct loss in money when low-grade seeds are purchased, and the resultant poor "plant" which is almost certain to follow when they are sown, a point of very considerable importance is the fact that many weeds are introduced on to fresh farms with impure seeds. When it is stated that the cash value of the seeds of the principal farm crops sown in Great Britain may amount to about *7 millions sterling* per annum, it will be realised how much loss may be incurred by the inclusion of only a very small proportion of weed seeds or by using seed of low germinating power, and how very necessary it is that this immense quantity of seed (for some 12,000,000 acres) should be as pure as it is possible to make it, and of high germinating capacity so that the crop quickly covers the soil.

At the present time it is most important that the maximum yield of foodstuffs should be obtained from the land under the plough, and this can only be done by keeping the land in a high state of cultivation and sowing pure seed of high germinating power.

Farmers should submit samples of the seeds they purchase, under guarantee and subject to analysis, to a competent agricultural botanist at one of the Agricultural Colleges or to a County Agricultural Organiser, and only accept the bulk on his recommendation to do so. Instructions as to sampling, labelling, etc., should first be asked for from the expert concerned. Data as to the addresses to which farmers may send samples are given in the Table on pp. 1057—1060. It is very desirable that samples should be submitted as early as possible, in order that good time may be given for the test to be completed before the seed is purchased or sown as the case may be. Replies cannot satisfactorily be given immediately samples are submitted for examination, some days at least being required for a test in regard to germinating power. Purity only may be reported on at once. Every farmer who has not yet read the Board's Special Leaflet No. 24 (*Seed Testing*) should immediately send for a copy,* and act on the advice therein given.

* It may be obtained free from The Secretary, Board of Agriculture and Fisheries, Whitehall Place, London, S.W. The letter or post card of application need not be stamped.

Statement as to Seed Testing in Various Districts of England and Wales.

Address to which samples may be sent for examination, and Counties served by each Centre.	Facilities for Seed Testing.	Fees payable.	Extent of Seed Testing in past 5 years.	Information given by Complete Report on a Seed sample.	Whether the Seed Testing conducted in the past 5 years has led to any improvement in the seeds supplied by seedsmen.
Professor R. H. Biffen, M.A., School of Agriculture, Cambridge University. (*Bedford, Cambridge, Essex, Hertford, Huntingdon, Isle of Ely, Lincs [Holland and Kesteven], Norfolk, Northampton, Soke of Peterborough, E. and W. Suffolk*).	Ample	None charged to farmers of counties named.	In the year 1914-1915. 21 samples were tested.	Purity (and percentage of grit, &c., chaff, and weed seeds in detail), percentage germination.	Samples insufficient to base any conclusions on.
Professor J. Percival, M.A., University College, Reading (*Berkshire, Buckingham, Dorset, Hampshire, Isle of Wight, Middlesex, Oxford.*)	Complete equipment	Nominal to farmers in counties named.	Farmers have not yet availed themselves of the seed-testing facilities to any large extent.	Statement as to purity and impurities, germination capacity (also hard seeds and dead seeds).	—
T. J. Jenkin, B.Sc., Agricultural Dept. (Advisory Section), University College of North Wales, Bangor. (*Anglesey, Carnarvon, Denbigh, Flint.*)	—	Seeds are tested free of charge for farmers in the counties named.	Started in 1913: 1913, 70 samples; 1914, 52 samples; 1915, 300 samples.	Purity and germination, with particulars of impurities.	Too soon to say.
W. B. Mercer, B.Sc., Armstrong College, Newcastle-on-Tyne. (*Cumberland, Westmorland, Durham, Northumberland.*)	—	Practically no charge.	Year ended 30th September, 1915—161 samples tested fully and 103 samples partially.*	Percentage of purity; nature of impurities; percentage of germination; energy of germination; real value.	It is satisfactory to note that the practice of giving a guarantee with seeds is steadily increasing.

Address to which samples may be sent for examination, and Counties served by each Centre.	Facilities for Seed Testing.	Fees payable.	Extent of Seed Testing in past 5 years.	Information given by Complete Report on a Seed sample.	Whether the Seed Testing conducted in the past 5 years has led to any improvement in the seeds supplied by seedsmen.
W. Goodwin, M.Sc., Ph.D., Midland Agricultural and Dairy College, Kingston, Derby. (*Leicester, Derby, Lindsey, Nottingham, Rutland.*)	The temporary Botanical Laboratory is well equipped for the purpose.	No regular scale; free for *bonâ-fide* farmers.	Started in 1913; †1913, 23 samples; †1914, 102 samples; †1915, 97 samples.	Percentages of purity and germination; classification of impurities with approximate percentages of chief constituents. Written remarks on general character of sample, including an opinion on value of seed for purpose desired.	Difficult to state definitely, but results have probably been good.
P. Hedworth Foulkes, B.Sc., Harper Adams Agricultural College, Newport, Salop. (*Salop, Stafford, Warwick.*)	Two germinators and greenhouse.	1*s.* for complete report for farmers, 2*s.* for others (within counties named).	From 50 to 80 per annum, nearly all "Complete Report."	Purity, germination, real value, average weight of seed, indication of principal weed seeds present in sample.	Yes; but there is a great deal of apathy amongst farmers on the question of seed testing.
T. J. Young, M.Sc., F.S.I., College of Agriculture, Holmes Chapel, Cheshire. (*Cheshire.*)	Biological Laboratory provided with germinators.	A nominal one of 2*s.* 6*d.* for examination and report.	Twenty-five for complete report.	The names of the constituents, their percentage of germination and advice as to general suitability for any particular purpose.	Yes, it seems to have kept before users the necessity of obtaining seed from high-class firms who deal in seed of high quality and germination.
S. T. Parkinson, B.Sc., South-Eastern Agricultural College, Wye, Kent. (*Kent, Surrey, E. and W. Sussex.*)	Ordinary methods, including use of special germinator, but not the equipment for a special seed-testing station	1*s.* 6*d.* for a complete report.	Very few samples sent in, and those usually cereals. Average, 15 to 20 samples per year.	General remarks on the sample (weight, &c.), reference to noxious weeds, purity test, germinating energy and capacity.	Judging from the few samples sent it is unlikely that much improvement can have occurred. On the other hand, farmers are, perhaps, more particular in obtaining guarantees than was formerly the case

R. M. Wilson, M.Sc., East Anglian Institute of Agriculture, Chelmsford. (*Essex and Hertford.*)	—	1*s.* for report on purity, germinating power, and on the nature and proportion of foreign substances.	No exact figures, but the demand has been small, probably about a dozen samples a year. In 1915 the number was 19.	(*a*) Report on purity; (*b*) report on germination capacity, including energy of germination; (*c*) report on nature of impurities, and their effects (harmful or otherwise). The form of report recommended by the Agricultural Education Association is being adopted.	Too small to have had any appreciable effect.
J. D. Davidson (Principal), The Farm Institute, Sparsholt, Winchester. (*Hampshire.*)	No definite facilities, but tests are made if required.	Germination test, 6*d.* Germination and purity test, 1*s.*	—	Germinating capacity, germination energy, purity of sample	The work in seed-testing has been on a small scale.
W. Borlase, N.D.A., Cornwall Agriculture Department, County Hall, Truro. (*Cornwall.*)	In connection with the advisory work farmers are invited to submit samples of seeds for analysis. (Students in the Winter Agricultural Schools learn to identify all the seeds used on the farm—grasses, clovers, etc. At all centres samples are examined for purity, and the germination test is explained.)	Gratis	An average of about 150 samples per season. (104 samples in 1915).	The report on the sample sent gives in full detail the names and the percentages of all seeds present. Germination results are sometimes given when deemed advisable, and there is sufficient time.	Yes, very great improvement. "Farmers are much more careful now in the purchase of seeds than they were two years ago, having learnt that it is better to pay a good price for seeds than to buy the lowest-priced samples irrespective of quality." (1914 report.) "In some cases on the receipt of the analysis the farmer has refused to accept seeds for which he was negotiating, and one farmer returned seeds he had already purchased . . . It is only fair to add that many local firms are evidently doing their utmost to persuade farmers to purchase only seeds of high quality." (1915 report)

Address to which samples may be sent for examination, and Counties served by each Centre.	Facilities for Seed Testing.	Fees payable.	Extent of Seed Testing in past 5 years.	Information given by Complete Report on a Seed sample.	Whether the Seed Testing conducted in the past 5 years has led to any improvement in the seeds supplied by seedsmen.
F. V. Dutton, County Agricultural Laboratories, 1, Richmond Road, Exeter. (*Devonshire.*)	(At the County Laboratories, Exeter).	1*s.* per sample for a report.	18 samples for complete report.	Purity, germination, true value, weight of seed, germinative energy.	Out of 10,000 farmers in the county only 10 have sent samples during the last 5 years.
John Porter, B.Sc., Shire Hall, Hereford. (*Hereford.*)	(Agricultural Education Office.)	Free	About 6 samples in 1915 for the farmers; much work done for students.	Purity, quality, and germinating capacity	Rather difficult to say. The samples tested have usually been satisfactory.
J. H. Burton, M.Sc., Agricultural Education Office, Weston-super-Mare. (*Somerset.*)	(Analyses conducted by Mr. Burton.)	Free of charge ..	Forty-three for complete report. (3 years.)	Per cent. germination; per cent. purity—if sufficiently important, nature of principal impurities.	Hardly. Not sufficient done to influence the trade. Mr. Burton has not time to concentrate on the work or to try and get a large number of samples. A few farmers, however, have realised the value of seed testing, and send samples every year.

* Of these 264 samples, 59 were received from co-operative societies, 109 from farmers and 7 from seedsmen; while 30 were obtained from Cockle Park and 59 collected by the Adviser in Agricultural Botany.

† Including samples from wholesale seed merchants; seed mixtures purchased on guarantee of composition and germinating capacity supplied by vendors; seeds showing signs of overheating in stock or during storage; old seeds; seeds treated with preparations to prevent fungus and bird attacks; seeds infested with spores of fungus pests; and seeds of low germinating capacity where advice was required as to the quantity to sow per acre.

The Need for Destroying Weeds.—Closely connected with the question of pure seeds is that of foul land, and the Board desire to call the special attention of farmers to the great need for combating weeds, which are usually responsible for great loss in the yields of crops (*See* Leaflet No. 112, *Weeds and their Suppression*). On a properly weeded area the crop may be double that on an unweeded area; *e.g.*, in one case mangolds, grown under otherwise exactly similar conditions on the same field, yielded 37¼ tons per acre where two hoeings were given, and only 16¼ tons where there was no weeding after singling.

Further, a careful estimate has led to the conclusion that the annual loss actually due to the presence of weeds, and to the increased cultivations, etc., necessary to keep them in abeyance, amounts to about 20*s.* per acre in the case of root crops, 10*s.* per acre in the case of cereal, pulse, and other arable crops, 10*s.* on permanent grass, and 5*s.* on rotation grasses, etc., or about 16½ *millions sterling* per annum.

In this connection it may be remarked that in a Memorandum issued last year by the Farmers' Club it is observed that, "The biggest waste in agriculture is caused by weeds. As a rule, weeds are permitted by bad farmers only, and a determined attempt, notwithstanding all difficulties, should be made to get rid of the weeds so that the yield per acre of the crops we grow may attain the highest standard."

The general means available in normal years for the destruction of weeds are detailed in Leaflet No. 112 (*Weeds and their Suppression*). In view of the fact that a larger acreage than usual of cereal crops was grown last year, and is likely to be harvested in 1916, special precautions should be taken to prevent weeds getting the upper hand. Apart from mechanical means of destroying weeds usually practised, several points are especially deserving of notice:—

(1) Seeding of all weeds should be prevented by all possible means.

(2) All perennial weeds should be cut down frequently to exhaust the supplies of food stored up in their roots, and prevent storage of further supplies.

(3) An endeavour should be made to prevent weed seeds separated out in the course of threshing and winnowing and the refuse seeds from haylofts from again reaching the fields. Wherever possible these should be burnt. Farmyard manure, believed to contain weed seeds in any quantity, should be allowed to rot well before application to the land. Many weed seeds

may be present when meadow hay and chaff (barren glumes) of oats are fed to stock.

(4) In certain cases, where hand-hoeing is largely practised, corn crops may usefully be drilled in rows wide enough apart to permit of horse-hoeing, say, 8 in. to 9 in. apart. This is especially useful in the case of spring-sown corn.

(5) Where horse-hoeing cannot be practised, the wetter the climate, or the more the land is subject to the growth of annual weeds, the closer the drill coulters should be set. When weeds are plentiful it is advisable immediately after harvest to disc or lightly scarify the surface, with a view to encouraging the germination of annual weeds. These should afterwards be ploughed down.

(6) Where weeds are likely to be abundant it may also prove a good plan to sow part of the root "break" with a vetch mixture in autumn. This would not only "smother" out weeds but reduce the labour bill for roots.

Under the Norfolk four-course rotation the area devoted to roots imposes a severe strain on labour, even in normal times. At the present time, all indications point to the necessity for modifying the usual practice. It is well known that success in root-growing and the welfare of the crops that follow depend largely on careful, thorough, and persistent cultivation of the root "break." It is desirable, therefore, that farmers should adopt every practicable means of suppressing weeds at all stages of the rotation, as, for example, by the growth of heavy corn crops, and they should include in the root area such crops as will suppress weeds, save labour, and provide suitable supplementary keep for stock in winter. (*See* Special Leaflet No. 28, *Suggestions for the Cultivation of Catch Crops and Home-Grown Feeding Stuffs*, and Special Leaflet No. 43, *Suggestions for Saving Labour*.)

Labour.

During the past year, no doubt largely owing to shortage of labour, weeds were unusually plentiful in many districts.

The shortage in manual labour may largely be met in so far as the destruction of weeds is concerned by the employment of women and children, working when necessary in gangs in charge of one or two older and practised hands; and of temporary workers who may be in a position to do work of this kind for short periods. In regard to labour, farmers should make much fuller use of the local Labour Exchanges.

TRIALS OF WILD WHITE CLOVER.*

DOUGLAS A. GILCHRIST, M.Sc., F.R.S.E.,

Professor of Agriculture, Armstrong College, Newcastle-upon-Tyne.

AFTER seeing the results of trials conducted near Chester, the writer commenced trials with Wild White Clover in North Wales in 1893, but, as he moved to Reading in 1894, these trials were not followed up. The trials commenced near Chester in 1886 would undoubtedly have been more successful if basic slag had been used, as at Cockle Park, for the development of this plant. One of the seeds mixtures then used near Chester had previously given good results in Kent. Perennial rye grass, crested dogstail, and wild white clover made up the Kent mixture, which gave a good sole of grass and a close sward of white clover in the first year, and attracted the favourable attention of many farmers who visited the plots. In order to show how the cost of wild white clover seed has increased since the first trials were made at Cockle Park, it may be noted that the price per pound was 1*s.* 6*d.*, or rather over, from 1906 to 1910; 2*s.* 10*d.* in 1911; 4*s.* 3*d.* in 1912; 3*s.* 6*d.* in 1913; 3*s.* in 1914; and 7*s.* in 1915. There are indications that, for 1916, prices may vary from about 14*s.* to 20*s.* a pound. The production has steadily increased, but not at all in proportion to the demand.

Trials at Cockle Park.—The first trial of wild white clover at Cockle Park was begun in 1906. A small area of the poorest type of boulder clay soil in Tower Hill Field had been summer fallowed in 1905 and sown with wheat that autumn. In April, 1906, plots (among others) were sown with the following seeds (per acre):—

	Plot I.	*Plot II.*
Perennial Ryegrass	6 lb.	6 lb.
Italian Ryegrass	6 ,, ...	6 ,,
Cocksfoot	6 ,, ...	6 ,,
Timothy	3 ,, ...	3 ,,
Meadow Fescue	8 ,, ...	8 ,,
Red Clover	4 ,, ...	4 ,,
Alsike Clover	2 ,, ...	2 ,,
White Clover	4 ,, ...	4 ,,
Wild White Clover	—	4 ,,

* This article is in continuation of that which appeared in the issue of this *Journal* for December, 1909, p. 713. It summarises the results of trials with Wild White Clover since that time at Cockle Park, the Northumberland County Agricultural Experiment Station, and endeavours to give some indication of the most valuable results now being obtained throughout the country from its use. Mr. James Hunter, Chester, informs the writer that he first heard of Wild White Clover about thirty years ago, when the trials of grass and clover seeds, referred to in the first article, were made near Chester. The seed of the plant then came from the Weald of Kent, and one or two farmers there continued to save this seed thereafter. Mr. Boddy, Shoreham, Kent, supplied the seed for these trials. He collected ripened heads of wild white clover and separated the seed from these by whipping them against a board. There were, however, few enquiries for seed till the results of the Cockle Park trials became known and practised in other parts of the country, with the result that it has since commanded high prices.

These plots have now produced hay for 9 years (1907-1915), with the following results per acre:—

	Plot I., without Wild White Clover.		*Plot II., with Wild White Clover.*	
	A.—10 cwt. basic slag for 1907, 1910, and 1913.	B.—No Manure.	A.—10 cwt. basic slag for 1907, 1910, and 1913.	B.—No Manure.
	cwt.	cwt.	cwt.	cwt.
1907 ..	39½	6¾	38	18
1908 ..	23½	5¼	33½	9¾
1909 ..	15¼	8	25⅝	11
1910 ..	16¼	4¾	39¾	11½
1911 ..	18¼	4½	30¼	9
1912 ..	25½	13	51	13½
1913 ..	25¼	3½	35	4½
1914 ..	22	5	34¾	11
1915 ..	10½	1½	23½	2¾
Av. (9 years)	21¾	5¾	34½	10

The poverty of the soil is strikingly shown by the fact that, where no manure was applied and no wild white clover was sown, the average crop of hay for 9 years was only 5¾ cwt. an acre.

Wild white clover, without manure, increased the average crop of hay to 10 cwt., still an unsatisfactory result. On this plot, however, the wild white clover plants are now quite plentiful, but have a hard struggle for existence.

Where no wild white clover was sown, basic slag gave an excellent result in the first year, mainly because of its stimulating effects on the cultivated clovers. These, however, died out after that year. The nitrogen collected by their roots, however, helped the grasses considerably, especially in the following year, and by 1912 wild white clover plants, native to the soil, commenced to occupy part of the ground in patches. Yet even in 1915 these native plants have not covered the soil in anything like the satisfactory way that the sown wild white clover has done.

Where high-grade basic slag was applied and wild white clover was sown, it will be seen that 12¾ cwt. more hay has been produced per acre annually than where slag was applied but no wild white clover was sown, while in addition the aftermath has also been much more valuable.

These plots show in the most decisive manner the lasting effects of wild white clover and the need for this plant being manured with a phosphatic manure like basic slag on a poor clay soil of this character. The lime of the slag is probably useful, as well as the phosphates.

A plot sown with the same seeds mixture containing wild white clover, and dressed with 10 tons of dung per acre every third year, has given an average of 30⅔ cwt. of hay during the 9 years, so that basic slag, at half the cost of dung, has given about 4 cwt. more hay per acre annually. Another plot sown with the same seeds mixture, including wild white clover, received

the same dressings of basic slag and dung conjointly, with the result that on the average 1¼ cwt. less hay per acre has been given by slag and dung than by slag alone. It should be specially noted that cocksfoot and other grasses were much more vigorous, and of a darker green colour, when growing with clover than by themselves in the first year's hay, as early as June, 1907.

It is clear that wild white clover, in common with other clovers, will give its best result if manured with a phosphatic manure like basic slag, and a potash manure if the land is deficient in that substance; and also, that grasses growing with clovers very soon benefit from association with them, probably because of the nitrogen collected by the clover roots.

About 4 acres of clay of the poorest character, which had previously failed to grow any crop in a satisfactory manner, was summer-fallowed in 1906 and sown with wheat for 1907. This land was sown in the same spring with the seeds mixture given on page 1063 (Plot II.), containing wild white, but no ordinary white clover. Ten cwt. per acre of high-grade basic slag were applied for 1908, and again every third year thereafter. For the 8 years, 1908-1915, the average amount of hay grown per acre has been 36 cwt., while valuable aftermath, rich in clover, *and wild white clover alone*, has been grown in each year.

As a result of these trials about 7 acres of the poor clay soil at Cockle Park have been sown every year since 1909 with a seeds mixture for three years containing wild white clover. In every case the nurse crop has been barley, receiving no manure, while the previous root crop received dung alone, 12 tons per acre. In the early winter, after each barley harvest, 10 cwt. per acre of high-grade basic slag (39 per cent. phosphates) *alone* have been applied on the young seeds. The following table shows the weight of hay produced per acre for three years thereafter in four successive periods of three years:—

First Year.		*Second Year.*		*Third Year.*	
Year.	cwt.	Year.	cwt.	Year.	cwt.
1910	57½	1911	31	1912	49¼
1911	29¼	1912	43¾	1913	47¼
1912	36	1913	49¼	1914	41¼
1913	52	1914	52	1915	29
Average	43¾	Average	44	Average	41¾

These results justify the conclusion, arrived at in 1909, that the poor clay land under cultivation at Cockle Park should be put under a six-course rotation, and that seeds hay should be taken for three years in succession, in the manner described above. This poor clay soil had previously failed to grow cultivated clovers, except in a very erratic manner and practically only in the first year. Trials in the Lower Nursery and in the College

Garden had shown that clovers can easily be choked out by too thick a sowing of grasses, while the meadow hay plots in Palace Leas Field had shown that 24 per cent. of clovers could be developed in the herbage by applications of basic slag and a potash manure, whereas, when sulphate of ammonia was added to the foregoing, clovers were so repressed that only 6 per cent. of them were present in the herbage.

The above results, for four three-year periods in succession, fully demonstrate that the proper use of wild white clover and basic slag will produce crops of hay of over 2 tons per acre annually on land on which it was not possible to grow as much as half these quantities before, while the aftermaths are more than doubled in value, and are as good in the second and third years as in the first, and contain more clovers.

The seed mixture used for growing these crops of hay practically consisted per acre of the following:—

16 lb. Perennial Ryegrass.
10 ,, New Zealand Cocksfoot.
4 ,, Timothy.
4 ,, Singlecut Cowgrass.
1½ to 4 lb. Wild White Clover.

The seeding of the last has been reduced, owing to its high cost, to 1½ lb. per acre (and a small amount of alsike clover and trefoil substituted), as it has been repeatedly found elsewhere that this quantity of seed is ample when a good take of seeds can be secured. Incidentally it should be noted that New Zealand cocksfoot and singlecut cowgrass have especially valuable characteristics.

Trials in Aberdeenshire.—Mr. James Cruickshank, Port Erroll, Aberdeenshire, sowed, in 1910, an 8-acre field in poor condition with a seed mixture which included 1 lb. of wild white clover. He did not notice any special result till 1913, when the field was grazed. In that year this plant gave a close and green sward till the end of the grazing season, and it was estimated that it produced double the amount of pasture of any field on the farm. This good result was continued in 1914. In January, 1915, he gave it a heavy dressing of basic slag, and, as a result, he reports that the pasture has simply been splendid in 1915. He has now sown many of his fields with seed mixtures containing wild white clover, which are all developing well.

In 1910 samples of wild white clover were sent to over 80 members of the Agricultural Students' Association of Aberdeen University. By the third year it was reported that this plant was producing an excellent sole of pasture, when the seeds were grazed. In one case in 1913 oats were grown after a two years' ley, and the crop proved to be far more vigorous after wild white clover than when this was not included in the mixture. In 1914,

two of the members thrashed equal areas of oats which had been grown after ley, sown with, and without, wild white clover. At one of the centres 60 bush. per acre of oats were grown after wild white clover and 52 bush. after ordinary white clover. At the other centre the amounts of grain were 68 and $50\frac{3}{4}$ bush. respectively.

Other Trials of Wild White Clover.—The excellent crops of oats after a three years' wild white clover ley are most satisfactory at Cockle Park.

At Mr. Wardle's farm, Fallowfield, near Hexham, the oat crop was increased by over 14 bush. per acre in 1913, when it followed a wild white clover ley, instead of a ley on which ordinary white clover was sown.

Mr. George Rea, North Doddington, Wooler, Northumberland, has included wild white clover in seed mixtures on Mr. Charles Mitchell's Home Farm, Pallinsburn, Northumberland, with the result that the first and second years' seeds were of a most satisfactory character in 1915. They were grazed and carried a heavy stock with excellent results. Wild white clover herbage was abundant throughout, and the bulk and nutritive value of the grasses were evidently greatly improved by their association with clover.

Mr. J. Cleghorn, who has made known with energy the merits of this plant in North Northumberland, *and how it should be treated*, reports that Mr. Waugh, Duddo, obtained a greatly increased yield of oats after wild white clover, and that Captain Lambton has marvellously improved his rotation pastures by its use in the Glenvalley, close to the Cheviots.

Dr. Voelcker has obtained striking results with it on the Royal Agricultural Society's Station at Woburn.

Mr. Murray Thomson reports that Mr. Parkin Moore has greatly improved his pastures at Whitehall, Cumberland, by its use.

Mr. J. P. F. Bell, Fulforth, County Durham, has obtained, on large areas, crops of hay and aftermaths on temporary leys, and increased crops of oats thereafter, of as satisfactory a character as those at Cockle Park.

Results of an equally good character are being given, not only throughout the four northern counties of England, but in all parts of the United Kingdom. One of the most satisfactory results is that the period of many years which formerly existed between the sowing down and the making of a pasture practically disappears when wild white clover is properly used.

Securing Seed of Wild White Clover.—The seed of true wild white clover can only be obtained with certainty from pastures that have been laid away for a considerable number of years, and on which no seeds have been sown during that time. A safe

limit would probably be 20 years since the pasture was laid down. On such pastures wild white clover can frequently be developed to a large extent by the proper application of basic slag or other phosphatic manure, with probably the addition of a potash manure if the soil is of a light character. It is important to note that wild white clover should be the particular wild clover present in such pastures. If there are many plants of wild red clover, or yellow suckling clover, or other such plants, the wild white clover seed will contain a considerable amount of these seeds.

"Once grown" wild white clover has given quite satisfactory results, and is found to retain the characteristics of wild white clover. This "once grown" wild white clover is produced from leys in which true wild white clover is the only clover used in the seeds mixture. When wild white clover seed is thus obtained it is most important that the original seed should be that of true wild white clover, so as to ensure that any such seed should not be more than "once grown" from true wild seed. Professor M'Alpine, of the West of Scotland Agricultural College, found that up till the third generation the plants produced from such seed have the true wild characters. This has also been shown in the College Garden at Newcastle. At the same time it is not desirable that seed offered to the public should be more than "once grown" from the true wild form. Mr. J. H. Marshall, Bebside, Northumberland, has saved sufficient wild white clover seed from an old meadow for the last 5 years to serve his own purposes, and in 1915 has harvested 10 cwt. of this valuable "once grown" seed from a ley in its fourth year, thus showing that this seed can be harvested quite satisfactorily in Northumberland. He grazed this ley till 1st June in 1915 thus securing a larger proportion of clover to grass plants when the ripened clover was cut for seed early in September. A second cut of clover in the same season is too late to mature seed in Northumberland, as it will usually do in the counties further south, where clover is harvested for seed purposes.

As the cost of the seed is likely to be high for 1916, only small quantities can be sown per acre. At Cockle Park 1 lb. per acre has given quite a close and satisfactory aftermath after first year's hay, so that even ½ lb. per acre is likely to give good results, provided that the seeds are sown under the best conditions of tilth, and that the young plants are developed by a manure like basic slag. The attention of growers of clover seed has been drawn by the writer to the importance of this plant, and there is every likelihood that the supply of it, either in the original or "once grown" form, will be much more abundant in future years.

LINSEED AS A FARM CROP.

COMMUNICATED BY THE BRITISH FLAX AND HEMP GROWERS' SOCIETY, LIMITED.

LINSEED, either in the form of ground linseed or as linseed cake, has long been regarded as a food of special value for farm stock, more especially for milking cows and fattening bullocks, and as a "finishing off" food it seems to be quite unique. Ground linseed is of great importance in the rearing of calves. At the price to which these commodities have risen during recent years they have become so expensive as to preclude their general use on such a scale as would be desirable. The question, therefore, arises whether the farmer can grow linseed for his stock at a smaller cost than the price he must pay for it under existing conditions.

The encouragement and development of linseed growing in this country has been undertaken by the British Flax and Hemp Growers' Society, Limited, and information has been collected and experiments have been conducted to ascertain the best variety to grow and the prospects of growing this crop at a profit to the farmer. Although the experiments are not yet concluded, the circumstances of war are causing a growing scarcity of linseed and its products, so that it seems desirable to place on record the facts in support of the conclusion that on suitable soil, with the right kind of seed, considerable profit may be made by growing linseed as a farm crop.

General Considerations.—The constituents of linseed which are of chief value to the farmer from the point of view of a food-stuff are the *oil* and the *protein*, the popular opinion amongst farmers being that it is the oil in the linseed cake which has the special property of giving "bloom" to the coats of animals, and which keeps them "in condition" in a way that no other cake does. For this reason farmers are always ready to pay more for a cake rich in oil than for one that is poor in oil. The value of the protein in the seed, both from the feeding and the manurial standpoints, must not be overlooked. It is interesting to find from an examination of a large number of samples that, generally speaking, those samples which are rich in oil contain a large proportion of protein and those which do not contain so much oil are also more deficient in protein.

The constituent of linseed which is of chief value to the factor, from the point of view of crushing, is the *oil*. It may be said, therefore, that samples of linseed which contain the highest percentage of oil are of the greatest value to the farmer

as a foodstuff and also to the crusher as a source of oil. The rational way of valuing linseed, therefore, is on its oil-content: oil per acre from the farmer's point of view and oil per ton from the factor's point of view.

Owing to the fact that flax (*Linum usitatissimum*) is grown not only for the seed it bears (*linseed*) but also for the fibre which is contained in the stem (*line*), some confusion exists in the minds of farmers as to the kind of seed to sow for raising a linseed crop. It can be stated definitely, however, that seed which is usually sown in Ireland, Belgium, Holland and North Russia for the purpose of raising crops of tall, single-stem flax plants for fibre production are not the kinds best suited for the production of linseed. For the latter purpose a type of flax plant is required which exhibits a branching habit, produces abundance of seed, and which does not grow to a height of more than from about 18 in. to 2 ft.

With the object of deciding upon the best variety or kind of linseed to sow, a large number of samples from different parts of the world have been examined in the laboratory and in the field during the past four years. Of those which have been tried, four kinds, namely, *Moroccan*, *La Plata*, *Dutch* (*white flowering*) and *Steppe* seed proved to be the most promising, and these have been grown in various parts of the country on trial plots of ¼ acre arranged in duplicate, so that the area devoted to each kind of seed was ½ acre at each centre.

The results recorded in Table II. show that in each case the seed known in the trade as "Plate" or "La Plata" linseed has proved to be the best suited where a linseed crop is desired.

Farmers are sometimes deterred from attempting to grow linseed owing to the belief expressed by some writers that the climate of this country is not suitable, and that linseed grown at home contains appreciably less oil than that which is usually imported. There being very little reliable information upon which to base such a statement, it has been necessary to examine a large number of samples of imported linseed, to grow them in this country and examine them again. Typical results are given in Table I., and it will be seen that there is no foundation for the belief that linseed grown in England is in any way inferior in oil to the imported samples from which it is raised; indeed, in some cases the results show an increase in the oil content as well as an increase in the weight of the individual seeds, and, as a whole, the figures compare favourably with the average—40·7 per cent.—of 52 samples of Indian-grown linseed.

TABLE I.—*Showing Relation between Imported Linseed and Linseed Grown in England.*

Variety of Seed.	Imported, 1912.		English Grown, 1913.	
	Oil Content.	Weight of 1,000 Seeds.	Oil Content	Weight of 1,000 Seeds.
	Per cent.	Grms.	Per cent.	Grms.
Moroccan. Mazagan (London market)	40·60	10·166	42·90 (Wye)	13·098
			40·13 (Camblesforth)	13·538
			39·06 (Seale-Hayne)	11·132
			40·86 (Harper Adams)	13·392
Plate. (London market)	38·45	6·108	42·80 (Wye)	8·840
			39·69 (Camblesforth)	9·204
			37·72 (Seale-Hayne)	7·712
			41·35 (Harper Adams)	8·744
Dutch. White-flowering (London market)	35·49	4·817	37·69 (Wye)	5·410
			35·08 (Camblesforth)	4·810
			34·60 (Seale-Hayne)	4·066
			36·71 (Harper Adams)	5·164
			34·08 (Holmes Chapel)	3·904
Steppe. Russian (Liverpool market).	38·90	5·076	41·50 (Wye)	7·198

Considerations of Soil.—Linseed requires no special kind of soil; it flourishes well on any good medium land. Provided that the land is clean, its selection is of minor importance compared with its proper preparation prior to sowing the seed. Although it may be said that land which is clean and well adapted to the cultivation of barley is suitable for linseed, the best results are obtained on a medium loam where the sub-soil is stiff—a good wheat bottom being eminently suitable.

Place in Rotation.—In linseed-growing countries many different rotations are adopted, a good practice being to grow the crop after corn. Wheat does well after linseed, and linseed does well after wheat, and it is the usual custom to grow linseed after a straw crop of some kind. Where the soil is light, however, it is best to make it follow a root or green crop which has been fed off by sheep.

Although it not infrequently happens where the land is poor that linseed is taken after clover, it is better to sow it with

clover or "seeds" underneath. This practice has the distinct advantage that the clover benefits by the small amount of shade offered by the linseed crop and at the same time weeds are kept in check.

Most authorities agree that the crop should not be grown frequently on the same land, because a condition of soil sickness sets in. The usual interval between two crops is about seven years.

Preparation of the Land.—Great stress must be laid upon the necessity of having the land deeply worked and firm, with but a shallow surface layer to cover the seed after sowing. This is of importance, because the linseed crop grows very rapidly—the growing period extending over some ten weeks only—and the most desirable conditions are those which cause this rapid growth to be both continuous and uniform. To obtain these conditions the land should be deeply ploughed in the autumn or early winter and be allowed so to remain until near the time of sowing. Suitable cultivations should be carried out prior to sowing in order to obtain a firm seed-bed and a fine tilth.

Manuring.—It is not desirable to sow linseed on land which is in a very high state of fertility, because such conditions induce luxuriant growth without a proportional increase in the amount of seed produced. For this reason, when farmyard manure is used it should be applied to a previous crop rather than for the immediate benefit of the linseed crop.

There is very little information regarding any advantage arising from the application of artificial manures in the case of this crop. It is not at all certain that the treatment recommended for flax when grown for fibre is the most suited to the requirements of the seed crop. As far as the Society's experiments have gone it seems that the yield of seed is increased somewhat by the application of superphosphate in conjunction with potash—*e.g.*, 3 cwt. of superphosphate and 1 cwt. of sulphate of potash per acre—applied just prior to, or at the time of, sowing the seed.

Generally speaking, however, unless the soil is poor, no very marked increase in the quantity of seed is brought about by the application of artificial manures; certainly no change of the oil-content of the linseed is brought about by these means. It is no longer seriously maintained that flax is an exhausting crop in the sense that it draws more from the land than do other crops.

Variety of Seed to Sow.—The selection of seed for sowing purposes is an important matter, as it is very necessary to employ only the very best seed, choosing that which is bright, plump and clean. The best plan is to choose one's seed merchant with care, so that one may be reasonably confident of getting the best quality seed on the market.

Of the several types of linseed which may be grown profitably in this country as a seed crop, experience goes to show that the best is that known as *La Plata* or *Plate Linseed*. This is one of the medium large-seeded varieties which grows to about 2 ft. in height and exhibits a marked tendency to branch at the base. When both yield of seed and oil-content are taken into consideration, *Plate Linseed* is found to be a better type to grow than either *Moroccan Linseed, Steppe Linseed* or *Dutch White Flowering Linseed*.

When making use of these imported seeds for sowing purposes it is necessary either to dress the seed carefully to free it from weed seeds, or to stipulate that this must be done by the merchant, otherwise serious trouble may be encountered by sowing foreign weeds on the farm.

TABLE II.—*Relative Merit of Varieties of Linseed Grown.*

Varieties.	Yield of seed per acre.	Per cent. oil.	Oil per acre.	Oil per acre (Plate=100).	Relative order.
Wye—	cwt. lb.		cwt.		
Moroccan	12 25	42·9	5·24	84	3
La Plata	14 70	42·8	6·25	100	1
Dutch	11 80	37·7	4·43	71	4
Steppe	13 53	41·5	5·61	89	2
Harper Adams—					
Moroccan	8 67	40·9	3·51	90	3
La Plata	8 97	41·3	3·64	100	1
Dutch	9 74	36·7	3·54	97	2
Camblesforth—					
Moroccan	5 67	40·1	2·24	92	2
La Plata	6 12	39·7	2·43	100	1
Dutch	4 74	35·1	1·63	67	3
Seale-Hayne—					
Moroccan ..	1 21	39·1	0·47	35	2
* La Plata ..	3 63	37·7	1·34	100	1
Dutch ..	0 106	34·6	0·33	25	3

* At this centre the season was a very wet one, and great difficulty was experienced in harvesting and drying the crop.

Time of Sowing.—The best plan is to sow as early as possible—as soon as the soil and weather will permit—so that the seed will germinate slowly and have a good start while moisture is in the top soil.

Linseed is a crop which is rather easily affected by drought in its early stages of development.

Fear need not be entertained that moderate frost will damage the plant—it is quite able to withstand several degrees of frost without injury.

Usually it is possible to sow on light land at the end of March or the beginning of April, but on heavier land it is seldom possible to get the seed sown before the end of April. There are, however, many varying influences which have to be taken into account and only the farmer can say when his land is in suitable condition for receiving the seed; the matter of importance being to get it in as early as possible so that advantage may be taken of the early linseed harvest to get a catch crop on the same land, unless clover or "seeds" has been sown in the first instance.

Mode of Sowing.—As with other crops, the seed may be sown either by broadcasting or by drilling, but owing to the slippery nature of the seed it is seldom possible to effect uniform hand distribution except by experts. This means that broadcast sowing is generally best accomplished by using the fiddle.

Drilling possesses the distinct advantage that it ensures the seed being buried at a uniform depth and it facilitates the cleaning of the crop by hoeing. A light corn drill may be rendered suitable for the purpose by setting the coulters as close together as 6 in. If "seeds" are to be sown underneath they should be put in immediately after the linseed is sown, and in this case the linseed may also be sown by means of a seed-barrow.

It is desirable to have the seed buried only to about ½ in. or 1 in. below the surface, light harrowing followed by light rolling being all that is necessary after sowing.

Rate of Sowing.—When deciding at what rate per acre to sow linseed, it is necessary to take into consideration (1) the germination capacity of the seed; (2) the size of the seed; (3) the habit of the plant; and (4) the method of sowing.

The importance of knowing the percentage of dead seeds in any sample of seed sown will be obvious to all farmers, and with linseed it is particularly desirable to have this information, because bad storage may impair the vitality of the seed very considerably. The following are the average percentages of live seeds found in the samples of imported linseed which have been examined:—

Variety.	Germination, per cent.		Variety.	Germination, per cent.	
	1913.	1914.		1913.	1914.
	Per cent.	Per cent.		Per cent.	Per cent.
Plate seed ..	72	100	Steppe seed ..	94	100
Moroccan seed ..	98	100	Dutch ,, ..	92	37

The size of the individual seeds must also be taken into consideration, because the seeds of some varieties, such as that coming from Morocco, may be twice as large as others, such as that coming from Holland.

Variety.	Weight of 1,000 seeds.		Variety.	Weight of 1,000 seeds.	
	1913.	1914.		1913.	1914.
	grms.	grms.		grms.	grms.
Plate seed ..	5·98	6·10	Steppe seed ..	4·91	5·07
Moroccan seed ..	9·96	10·16	Dutch ,, ..	4·25	4·81

It will be seen from the above table that, if the germination percentage of these varieties were the same, a given weight of the largest grained variety (Moroccan) would give less than half the number of plants that would be given by the same weight of Dutch seed. This is obviously of great importance, although it is a point which is seldom taken into consideration.

It is also desirable to bear in mind that some varieties of linseed differ in habit from others; for instance, Dutch seed, and to a less extent Moroccan seed, give plants which show little tendency to branch at the base—being, in this respect, unlike Plate seed. This means that to get a full crop less seed of the last variety may be used.

It is generally understood that drilling requires less seed than broadcasting, and it is unnecessary here to do more than mention the fact.

The following are the quantities of seed per acre which would be required for broadcast sowing when the germinating capacity in each case is that already given for 1914 :—

Plate seed ..	91 lb.	Steppe seed ..	86 lb.
Moroccan seed ..	166 lb.	Dutch ,, ..	219 lb.

Weeding.—Provided the land is moderately clean it is not so necessary to weed the crop carefully as is customary when flax is grown for fibre. Where the seed has been drilled

it is usually sufficient to hand hoe once and to keep the larger weeds down by spudding.

It is desirable to remove gross weeds, such as dock, thistles, convolvulus, and dodder, at an early stage. Linseed being a crop which affords less shade to the ground than other grain crops it frequently happens that weeds make considerable headway unless clover or "seeds" are sown underneath.

Harvesting.—Linseed continues to flower for some time and consequently ripens unevenly—the plants carrying ripe and green capsules even at harvest time. This fact is not detrimental to good harvesting, because, like wheat, it ripens in the "shock." It is everywhere agreed that the best practice is to harvest linseed when the stems have turned yellow and the lower leaves have fallen. At this stage an examination of the seeds within the older capsules shows them to be bright, plump, and uniformly pale brown in colour. This degree of ripeness is generally reached at about the middle of July, prior to the ordinary corn harvest.

It is not wise to allow the crop to stand until the majority of the capsules are dead-ripe, because considerable loss of seed thereby ensues when the crop is harvested. Careful handling is more necessary with the linseed crop than with other grain crops, because the seed "bolls" become entangled and are easily detached from the straw.

If the area of linseed is small it is obviously the best course to cut it with a scythe, but with larger areas an ordinary reaping machine requires very little adjustment to deal with the crop satisfactorily. The sheaves should be made up small so as to allow drying to proceed rapidly, and they should then be "shocked" in the ordinary way, and carted when thoroughly dry.

Threshing.—The best method of threshing linseed at the present time is to use an ordinary threshing machine, and to achieve the best results the following adjustments are recommended. About two-thirds of the cavings riddle should be covered with a piece of sacking to prevent any large amount of the cavings falling through the riddle along with the seed and chaff. The ordinary size riddle being large enough as to allow unbroken seed "bolls" to pass through with the seed, a three-sixteenth-inch "chob" riddle is recommended. The unbroken seed "bolls" should be passed through the drum a second time. Unless the drum of the machine be set close and a high speed be maintained, and the straw be carefully fed into the machine, the straw may have to be put through a second time to remove all the seeds.

Linseed being much smaller than the seed of other grain crops, only the finest riddles should be used.

Where only a small area of linseed has to be dealt with, threshing may be accomplished with a flail or by beating with a sloped mallet such as is used in Holland and Belgium. The latter has the advantage that threshing is completed in one operation, all the capsules being broken and the seed set free, whereas, when a flail is used a considerable number of the "bolls" remain whole although detached from the straw, so that it is necessary to crush them to liberate the seed.

After either of these modes of threshing has been followed, the seed can be freed from chaff and cleaned thoroughly by passing it through a winnowing machine fitted with the finest riddles.

Yield.—In Table III. will be found the results of the trials which were carried out during the two years 1913 and 1914.

TABLE III.

Yield of Seed, Straw, and Chaff per acre, 1913.

Centre.	Soil.	Variety.	Seed sown 90 lb. per acre of all varieties. Seed.		Straw.		Chaff.	
			cwt.	lb.	cwt.	lb.	cwt.	lb.
South-Eastern Agricultural College, Wye, Kent.	Good medium loam.	Moroccan	14	32	13	28	9	0
		La Plata	16	108	17	27	8	56
		Dutch ..	13	40	23	84	8	14
		Steppe ..	14	84	23	56	8	84
	Poor chalk.	Moroccan	10	15	8	91	6	70
		La Plata..	12	32	12	84	5	70
		Dutch ..	10	9	18	14	7	98
		Steppe ..	12	22	15	42	7	98
Harper Adams College, Salop.	Free working loam.	Moroccan	8	61	10	14	7	84
		La Plata..	8	98	9	56	7	0
		Dutch ..	9	71	18	20	7	70
Camblesforth, Selby, Yorks.	Light sand.	Moroccan	5	68	10	84	9	0
		La Plata..	6	12	8	98	7	0
		Dutch ..	4	81	13	42	9	70
Glasfryn, Carnarvonshire, N. Wales	Medium light loam.	Moroccan	4	84	12	63	6	70
		La Plata..	8	98	16	0	6	105
		Dutch ..	0	42	22	2	9	70

TABLE III.—(*cont.*).

Yield of Seed, Straw, and Chaff per acre, 1914.

Centre.	Soil.	Variety.	Seed sown varied with each variety.*					
			Seed.		Straw.		Chaff.	
			cwt.	lb.	cwt.	lb.	cwt.	lb.
South-Eastern Agricultural College, Wye	Medium loam, chalky.	Moroccan	12	84	11	16	9	28
		La Plata..	13	8	11	96	9	84
		Dutch ..	10	104	14	56	9	47
		Steppe ..	10	80	15	16	8	0
Harper Adams College, Salop.	Good free working loam.	Moroccan	14	58	21	26	12	56
		La Plata..	16	96	21	11	7	60
		Dutch ..	10	64	21	18	8	30
		Steppe ..	15	96	21	11	7	54
Midland Agricultural College.	Light loam.	Moroccan	9	70	Not weighed.		Not weighed.	
		La Plata..	10	33				
		Dutch ..	8	21				
		Steppe ..	10	18				
Cambridge School of Agriculture.	Medium loam.	Moroccan	7	14	10	42	7	68
		La Plata..	7	48	11	84	8	16
		Dutch ..	4	6	15	100	6	0
		Steppe ..	7	12	14	0	7	16
Royal Agricultural Society, Woburn.	Sandy loam.	Moroccan	9	91	15	85	Not weighed.	
		La Plata..	10	9	14	10		
		Dutch ..	5	110	20	103		
		Steppe ..	7	53	17	52		

* Seed per acre :—Moroccan, 140 lb. ; La Plata, 85 lb. ; Steppe, 70 lb. ; Dutch, 200 lb.

Straw and Chaff.—Linseed straw is remarkably tough and wiry and rots down very slowly, and for this reason it does not make good litter for stock. There are, however, several ways of using it profitably. On the farm the straw is useful for making stack-bottoms, or for the bottom of covered yards. It is also very useful for thatching purposes, and lasts much longer than either wheat or rye straw.

The straw coming from the ordinary threshing machine is somewhat broken and tangled ; but if this is put up into press-packed bales it may be sold at the present time at about £4 to £5 per ton.

A very good tough paper can be made from linseed straw, and although at present there is only a limited demand for it

for this purpose, it is probable that if larger quantities were forthcoming it would be more seriously considered by paper makers and advantage would accrue thereby to the growers.

The chaff of linseed consists almost entirely of the remains of the broken seed capsules. It may be fed to stock in the same way as other grain chaff, ewes being particularly fond of it. It should be observed, however, that as the chaff contains a considerable amount of fibre, it is not very suitable for young stock, more particularly lambs.

Cost of Growing and Returns.—The cost of growing, on the lines indicated, should not exceed £6 per acre. The figures obtained in the two years' experiments referred to in Table III. show that when using "La Plata" seed a crop of about 17 cwt. of seed containing 40 per cent. oil may be expected under favourable conditions, and that the average crop from the five centres where it has been grown during the past two seasons amounts to 11 cwt. of dressed linseed.

At the present time, when the price of linseed is £21 per ton, an average crop should be worth £11 10s. per acre without taking into account the straw or the chaff.

The yield of straw has varied between 21 cwt. per acre at Harper Adams in 1914 and 9 cwt. per acre on the light sandy soil near Selby in 1913, the average for all centres being 13½ cwt. per acre. As already stated this can be sold at the present time if put into press-packed bales at £4 to £5 per ton. There is, in addition, about 7½ cwt. of chaff per acre which has been sold recently at £3 per ton. The value of the straw and chaff therefore may be put at nearly £4 per acre, which brings up the total value of the linseed crop to £15 10s. per acre.

When a small area has been grown for use on the farm for calf rearing or as a substitute for linseed cake it may be crushed or ground into a meal. It is probable that when ground it is in its best form, and in this state the "feed" is more easily prepared.

It must be pointed out that linseed cake is the residue of linseed after expressing the greater part of the oil, and that linseed is, therefore, much richer in oil than is the cake, as will be seen from the following figures:—

Analysis.	Moisture.	Digestible Oil.	Digestible Protein.	Digestible Carbohydrates and Fibre.
	Per cent.	Per cent.	Per cent.	Per cent.
Linseed (whole) ..	9	38	17	21
,, cake ..	12	9·5	25	32

One of the most satisfactory and economical ways of using linseed when grown for home consumption, apart from its use in calf rearing, would be to prepare a food mixture similar in composition to that of a good sample of linseed cake. This can be done by mixing together 2½ parts by weight of ground-nut cake, 1½ parts by weight of maize and 1 part by weight of linseed. The feeding value of such a mixture compares quite favourably with that of linseed cake, as may be seen from the following figures. At the present prices of the added materials, ground-nut cake and maize, it is estimated that such a mixture would be a more valuable food and would cost £1 10s. per ton less than linseed cake.

	Digestible Oil.	Digestible Protein.	Digestible Carbohydrates and Fibre.	Cost.**
	lb.	lb.	lb.	£
2½ tons ground-nut cake*	465	2,240	1,120	30 0 0
1½ tons maize ..	151	235	2,284	19 10 0
1 „ linseed† ..	851	381	470	11 0 0
5 tons mixed food ..	1,467	2,856	3,874	60 10 0
1 ton mixed food ..	293	571	775	12 2 0
1 „ linseed cake..	212	560	717	13 13 9

* Kellner's figures of digestible nutrients have been taken.

† These figures refer to samples mentioned in Table on p. 1079. The cost is the cost of growing as estimated above.

** London prices for ground-nut cake, maize and linseed cake (*see* p. 1150).

Grinding Linseed.—The question arises how best to grind linseed, because it sometimes happens when the grinding surfaces are of stone that the mill becomes clogged unless some absorbent material is added. The best material to mix with linseed for this purpose is previously crushed maize in the proportion of not less than one part of maize to five parts of linseed. This facilitates grinding by absorbing the oil which becomes pressed out of the linseed during the grinding operation.

WILLOW-GROWING AND BASKET-MAKING AS RURAL INDUSTRIES.

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THE term "basket-willows" defines those species of plants of the genus *Salix* which are grown for the making of basket-ware. In habit of natural growth they may be regarded as shrubs or bushes, and by this character they are readily distinguishable from tree-willows, which, when allowed to grow freely, become timber trees.

Amongst growers, merchants and makers, basket-willows are divisible into two main groups, viz.: (1) *Hard rods*, (2) *Soft rods*. These are only relative terms, but sufficiently intelligible to all handlers of willows, and indicate the main difference existing between the two classes. The "hardness" of any variety of rod is determined by its *working qualities* when in the hands of the basket-maker, and depends upon the proportions of wood and pith in the stem, as well as upon the character of the wood elements. "Hard rods" belong to the species *triandra* and *purpurea*, and "soft rods" to the species *viminalis*.

Rods of the two former species are finely tapering at their apexes, while in the case of the last the tips of the rods are more abruptly pointed. For this reason in some places the terms "fine tops" and "full tops" are used for distinction. Amongst a few the same two groups are distinguished as "willows" and "osiers," but in general these terms, particularly the latter, are used without regard to species.

The area of land devoted to willow cultivation in this country is not accurately known. The most important willow-growing districts are in Somerset (Langport district), in the Trent Valley, and in Lancashire (Southport district). Many acres are grown in Cambridgeshire and the adjoining counties, and also in the Thames and Severn Valleys.

The supply of home-grown material is not sufficient to meet the requirements of the English basket manufacturing industry, as the following figures regarding imports of basket-making willows show[1]:—

*Value of the Total Imports of Willows and Canes for Basket-making—Free of Duty.**

From :	1910.	1911.	1912.	1913.	1914.
	£	£	£	£	£
Germany	30,366	33,698	38,211	34,246	26,983
Netherlands	9,702	14,781	14,109	19,569	25,773
Java	3,005	7,058	4,911	10,477	12,269
Other Dutch Possessions..	8,177	7,292	1,754	7,896	7,297
Belgium	7,925	11,160	12,614	12,288	8,416
Other Foreign Countries ..	6,509	7,538	6,851	9,798	10,896
Total for Foreign Countries	65,684	81,527	78,450	94,274	91,634
Strait Settlements and Dependencies, including Labuan	14,360	21,091	17,747	28,852	33,349
Other British Possessions..	5,842	3,678	1,514	347	496
Total	85,886	106,296	97,711	123,473	125,479

There is scope for an increased production of English-made basket-ware, the annual importations being as given below:

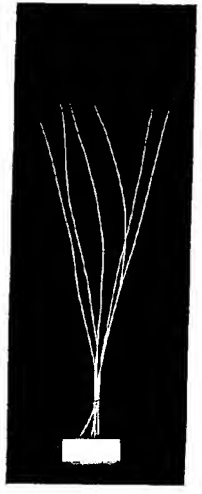
Value of the Total Imports of Baskets and Basket-ware—Free of Duty.

From :	1910.	1911.	1912.	1913.	1914.
	£	£	£	£	£
Germany	40,409	42,413	42,001	40,344	20,456
Netherlands	45,187	45,128	43,692	43,302	50,263
Belgium	52,127	51,717	52,741	52,162	37,099
France	19,502	21,072	19,428	19,689	12,271
Switzerland	2,367	2,456	1,864	1,145	410
Portugal	3,674	4,437	4,972	4,846	2,839
Japan, including Formosa and Japan-leased Territories in China	27,066	33,216	55,071	61,108	37,955
Other Foreign Countries..	5,064	3,675	4,614	6,295	3,855
Total for Foreign Countries	195,396	204,114	224,383	228,891	165,150
Total from British Possessions	925	2,047	1,501	1,196	1,771
Total	196,321	206,161	225,884	230,087	166,921

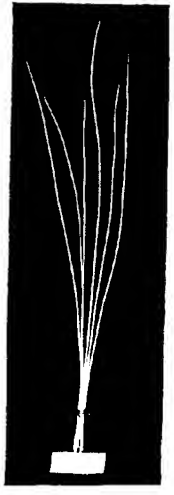
As to exports, the value of the basket-ware (the manufacture of the United Kingdom) exports amounted in 1914 to £21,178. The exports of willows and canes for basket-making (the produce of the United Kingdom) are so small as not to be separately

* It should be noted that the materials imported from the tropics for basket-making are canes and not willows but it is probable that they might be replaced by willows in many forms of basket-ware.

C. *Salix purpurea.*
var. *Dicky Meadows.*



B. *Salix triandra.*
var. *Black Maul.*



A. *Salix viminalis.*
var. *Longskin.*

S. viminalis (*Merrins*).
Longitudinal
and Transverse
Sections.

S. triandra (*Italiano*).
Longitudinal
and Transverse
Sections.

distinguished in the Annual Statement of Trade. The *re-exports* of willows and canes for basket-making were valued in 1914 at £7,330, and of baskets and basket-ware at £4,559.

Of late years many willow grounds have passed out of cultivation. These were mostly in the hands of small men who, in many cases, were also basket-makers. Various reasons are adduced to account for this decrease, the chief being:—(1) Increased cost of labour, (2) high rents, and (3) depression in the local basket-making trade.

Large basket-manufacturing firms and big growers, particularly in Somerset, have increased their areas and will probably continue to do so. Records of the market transactions in rods show a progressive rise in price since 1840. In that year "white" was sold at Sutton-on-Trent at £7 10*s.* per ton. In 1860 the price of rods of the same quality was £16 per ton, the seller paying carriage to Glasgow (about 55*s.* per ton). In 1914 the price of similar material was about £22 per ton. At the present time prices are high owing to the fall in the quantity of imported rods, and £42 per ton was recently paid for some fine quality "white."

Soil.—The soil best suited to the growing of willows is a rich, well-watered, heavy loam. The same kind of land does not suit all varieties of willows, even those closely related, equally well, but generally the greater the divergence from this type of soil the less likely is success to follow. Such land is capable of producing heavy yields of the best varieties for 30 or 40 years after planting. In a suitable season the rods would be of good quality, being esteemed by the basket-maker on account of their smoothness, toughness, elasticity, great length in proportion to thickness, freedom from side shoots, good colour either as "buff" or "white," and straightness in the grain.

Willows are generally grown on the low lands bordering on streams. No other crop is as suitable to periodically flooded land, and in regard to economic husbandry this is its right place. Willows will thrive on land situated above flood level provided it be maintained in good condition. Many acres of highly-rented pasture land so situated have been planted by enthusiastic growers with good results. It is claimed by basket-makers that these "high land willows" possess qualities superior to those of willows grown under any other conditions.

Preparation of Soil.—Details of cultivation and management of the crop, as practised by the best growers, are given in a publication issued by the Board.[2] The preparation of new ground to be planted is generally commenced in autumn or early winter.

The land is dug one spit, or trenched with the spade, or ploughed by means of horse or steam power. The method adopted depends upon the kind of labour available, the condition, shape and size of the ground to be planted, and the time of year when the operation is carried out. Good single-spit digging answers well in many cases. Trenching, which results in the reversal of positions of the upper and lower spits, is considered to be the best treatment, but it is a slow method and the cost (from 3*s.* to 5*s.* 6*d.* per 100 sq. yds.) makes it prohibitive. Where the ground is too irregular in shape, or too wet for the employment of horses or steam tackle, single spit digging and trenching are the only methods possible to adopt. Ploughing is resorted to when the acreage to be planted is large and a rapid completion of the operation is necessary. Steam cultivation, if properly done, is the most satisfactory method. The main object to be attained by this operation is to break up the subsoil to a depth of 12 or 14 in., and to secure a fine mould on the surface so that the insertion of the cuttings may be easily and expeditiously carried out.

Draining.—It is necessary during this stage to lay out a drainage system. This may be done by means of trenches or grips, pipe drains, or by a combination of the two methods. Surface drainage by means of trenches is usual on account of its general suitability to the circumstances, and the soil from the trenches is deposited on the intervening lands. In pipe-draining the pipes are either laid so as to give a "fall" or placed on the level. In the latter case the water in them rises and falls with the level of the water in the water-course into which the drain empties itself.

Probably more failures to grow desirable sorts of willows are due to an excessive amount of water in the soil than to any other cause. The water supply should be carefully studied before it is decided to plant new land. Frequent and heavy floodings are not harmful if followed by free drainage. An excessive supply of soil water causes purple and yellow discolorations to appear in the leaves, which afterwards fall prematurely, and the seasonal growth is poor.

Varieties to Plant.—Those varieties should be planted which are likely to prove most profitable to the grower. A basket-maker having willow ground grows the varieties which his business requires, and in cases where a constant local demand for rods of a particular type exists it is generally good policy on the part of a grower to cater for it.

A much wider market is open to rods of good than to rods of poor quality, and with such material substantial profits will remain

after expenses attending long railway transit have been paid. In making a selection of varieties for the planting of untested land, a prospective grower with little previous experience should seek and follow the best expert advice procurable. For basket-making purposes three species of willow are generally cultivated, viz.:—

1. *Salix viminalis* (*Osiers, Full tops, or Soft rods*).—Many varieties of this species are grown, of which the following only need to be considered in making a selection: Longskin, Yellow Osier, Merrin, French Osier, Reed Osier. The varieties of this species are characterised by their heavy yields, their adaptability to varied soil conditions, and the low quality of the rods which they produce. When one-year-old, the rods are used in the making of the coarsest kinds of basket ware. As "sticks," *i.e.*, rods which have been allowed to grow for two or more years, they are largely used as the main supporting parts of the heavier classes of articles.

2. *Salix triandra* (*Fine tops, or Hard rods*).—Many varieties exist, of which at least 20 are cultivated. The multiplicity of names due to local nomenclature and to *mutations* is perplexing in classification, but the following are well known and include the best of the varieties: Black Mauls, Black Germans, Italians, French, Stonerods, Glibskins, Dutch, Champions, Norfolks and Spaniards. Rods of the finest quality are produced from some varieties, and these are used in the making of the highest grades of wicker-ware.

3. *Salix purpurea* (*Bitter willows*).—Probably not more than 250 acres of this species are grown in this country, and most of this area is grown in the Southport (Lancashire) district. The chief commercial variety cultivated is the "Dicky Meadows," from which three sub-varieties have probably been obtained by selection, viz., Light Dicks, Dark Dicks, and Old Dicks or Red Buds. The varieties are said to succeed on sandy loam.[3] The rods are highly suitable for the making of small basket ware of superior quality. "Kecks" is a stronger-growing variety used largely for tying purposes.

Propagation.—In propagation, cuttings are obtained by dividing rods of one or two years' growth into suitable lengths. There does not seem to be any proved advantage in using rods of either age provided they are well grown. The top section of the rod is not planted. The usually recognised length is 12 in., but cuttings 10 in. and up to 16 in. in length are sometimes planted. Long cuttings are preferable in cases where the ground is light and loose and subject to strong winds. A greater encouragement is thus given to the development of a deep root system with corresponding firm hold on the soil.

Planting.—Planting should be done at a time when the ground is conveniently workable between the months of October and March. No planting should take place after sap movements have commenced. From 18,000 to 30,000 cuttings are required per acre, the precise number depending upon the varieties to be planted and the method of after-cultivation to be adopted. For

horse-hoe cultivation a greater distance is required between plants than in the case of hand hoeing. Basket willows grow straightest and freest from side shoots when massed, and experiments prove that close planting gives the heaviest yields, reduces the development of lateral shoots, and greatly retards the growth of weeds[4], but impoverishes the holt sooner[5]. Planting "on the square," *i.e.*, maintaining equidistance between the plants, is practised by some growers. This method gives the advantage of cross cultivation in horse-hoeing, but is not suitable in cases where the field to be planted is irregular in shape and slope and narrow in proportion to its length. Scaling recommends,

for varieties of *viminalis* distances of 20 in. by 16 in.
" " " *triandra* " " 18 " " 15 "
" " " *purpurea* " " 16 " " 13 "

The rows should be made straight and regular by means of a chain or line or marker attached to an agricultural implement. The cuttings may be pushed into the soft ground at regular intervals in the rows by the hand protected by leather across the palm, and the ground around made firm without damaging the cuttings.

After-Cultivation.—It is essential to success that the ground be kept free from weeds until the plants have become well established. Hoeing by horse-hoe or hand suffices. Three hoeings may be necessary during the first season and two during each of the two seasons following. Afterwards one hoeing is generally sufficient, as the close foliage checks the growth of weeds in summer.

Cutting.—The crop is cut between the months of October and May. Some growers take the first crop after two seasons' growth has been completed. Good first-year crops are frequently grown on the best land, but generally they are of little value on account of the many bent and branched rods present. Such rods, if allowed to remain on the heads until the end of the second season, would still be of poor quality, so that the result of this practice is that no financial returns from the land can be expected until the end of the third growing season. Many good growers always cut their rods during the first winter following planting, claiming that by so doing an opportunity is afforded the plants of producing a profitable crop at the end of the second year. On this point Scaling states[3] that "However poor the crop (maiden) may be, it must be harvested or cut off; for, if it was allowed to stand over until the second year, the united produce of the two years would be entirely worthless."

Cutting is performed by means of a specially constructed knife. The rods should be cut close to the stock and evenly on all sides. If snags are allowed to remain the heads become so unduly raised and outspread that they interfere with processes of cultivation. Badly cut heads also afford hibernating quarters for willow pests. The rods may be cut at any convenient time after leaf-fall and onwards until sap movements begin in the following spring.

Marketing.—The crop is marketed as "green," "buff," "white," or "brown." Freshly-cut rods, or "green," are sold as such in cases where the growers have not facilities for converting them into "white" or "buff." They are used to a limited extent in the making of rough articles in which long durability is not required, such as bottle-crates, cheese-hampers, etc.

The crop in this condition is heavy, and therefore because of high freight charges is not sent long distances. By disposing of the crop as "green" the profits are generally much less than would be realised by converting it into one of the other marketable forms. After cutting, the rods may be tied in bundles, stacked in the open and protected by thatch or a layer of peelings.

"Buff" rods are prepared from "green" rods either freshly cut or which have not become too dry in the stack, by boiling in long tanks, specially constructed for the purpose, for from two to five hours. By this means the tannin matter present in the bark is liberated and acts upon the underlying wood. The length of time of boiling depends upon the variety and the intensity of the colour required. The character of the land on which the rods have grown largely determines the buffing qualities. If grown on firm clay soil a good buffing variety, such as "Black Maul," will buff well after having been boiled for one or two hours, but if grown in a swampy part of the holt or on peaty land the same variety may be pale even after continuous boiling for five hours.

The bark is removed by hand alone, or by hand with the help of fixed "breaks," and the rods are then placed on end in the open air, being rested against a support of wire fencing. The intensity of colour produced increases with the length of time of exposure and its rate of change varies with the light conditions. As it is necessary that individual rods should be of the same shade throughout their lengths and that uniformity of colour should exist in all the rods from the same and subsequent boilings, their management at this stage should be in the hands of an experienced man. Drying is completed by placing the rods on shelves in a suitable room. Attacks by moulds, which cause

permanent discolorations and hence impaired value, are thus prevented. Grading, according to length, is done either immediately after removal from the boilers or after the rods have become dry. The rods are afterwards tied in bundles, and packed in a store room, and are then ready for sale.

"White rods" are prepared in the spring after the flow of sap has become active and before permanent additions have been made to the wood by secondary thickening processes. Cell activity commences in the region of the apexes of the shoots and travels downwards. Consequently a rod may be "peelable" in its upper portion, while at the butt the rind is still firmly attached to the wood. A backward spring, suddenly followed by a few fine warm days, causes rapid sap-flow, which is closely followed by rapid development of new wood. Under such conditions satisfactory peeling may not be possible for longer than three or four days. Under opposite conditions the peeling period for a variety may last for 12 days.

The brown ragged shreds sometimes seen at the butt ends of white rods indicate that peeling was premature, while the presence of similar shreds on their upper parts shows that the best peeling conditions had passed at the time when the process was carried out.

The peeling period may be prolonged by:—

1. *Growing* several varieties which attain in succession the best peeling conditions.
2. *Couching*, which consists in placing the bundled spring-cut rods in definite order, forming heaps.
3. *Piling*, in which the bundles are placed on the ground one layer thick, heating being prevented by repeated waterings and turnings.
4. *Pitting*, in which the rods—cut in March—are bundled and placed on end in ditches or in specially constructed pits through which water is induced to flow. Root, flower and leaf development take place, but secondary thickening is slow so that peeling may be continued until July.

The rods are peeled by hand assisted by the "break," female and young labour being employed for the purpose. Attempts have been made in the past to facilitate this operation by devising labour-saving machinery, but without success. A satisfactory decorticating machine is greatly needed. The freshly-peeled rods are dried in the open air by resting them against stretched wire, and afterwards graded according to length, bundled and stored in a dry place.

The rods which have been neither "buffed" nor "whitened" are known as "brown." This class includes rods of inferior growth, and consequently the value of such material is low. Large quantities are accumulated by some growers, much being ultimately wasted, while others manage to sell all their "brown" every year. It is used in the making of the lowest grades of basket-ware, such as vegetable baskets, potato hampers, crates, and scuttles.

Good rods always find a ready market, and the difficulty of selling increases with the poorness in quality. It frequently suits a grower to clear all his stocks annually, so as to save labour, to avoid accumulation and waste, and to make room for the next crop. In such cases close grading is purposely not practised. Manufacturers, on the other hand, prefer to buy material which is of the same size and quality throughout the bulk. The different branches of the basket-making trade are becoming so specialised that a maker can find little or no use for rods which are unsuitable in the making of his class of goods. The price he offers for ungraded rods and mixed willows is low, because the amount of suitable material present may fall short of his anticipated requirements, and expenses would be incurred in the sorting, packing, storing and marketing of the rods which he does not require. Grading according to length is not sufficient. Quality should be taken into account, and the basket-makers' requirements would be more fully met if this were more frequently done.

There are no established markets for willows in this country. The buying is in the hands of merchants and manufacturers, who regularly visit the willow-growing centres towards the end of the growing period to judge the value of the crop when standing and to purchase any dry material which the growers may have in stock. Frequently sales are effected by the forwarding of samples. At the Midland Agricultural College a list of the names of growers, merchants, and manufacturers in the area has been found useful. Growers are supplied with the names of buyers to whom samples and descriptions may be sent, and the latter are informed where the material they require is likely to be obtained. Sewage-farm-grown willows are often advertised for sale by tender, the buyer sometimes being required to cut and remove the crop. Provided such crops are well grown there seems to be no difficulty in finding a market by these means.

Basket-making.—Profitable willow-growing largely depends upon the existence of a flourishing basket-making industry. Until

the latter half of the last century the industry in this country was largely confined to villages and small country towns, and a miscellaneous class of basket ware was produced. The large importations of foreign-made wicker furniture, which could be bought at prices within the range of purchase of the majority of English households, resulted in these articles becoming common. The wealthier members of the community who could afford to purchase the similar but better-made and higher-priced English-made goods at once ceased to require them, and a depression in this branch of the trade followed. It was found to be impossible for the small English manufacturer to compete successfully with the foreign manufacturer in the making of articles of the same quality. The low price at which foreign-made goods can be sold is largely due to the specialisation of firms in the production of one class of articles and to the skill shown in organising the labour employed. The making of an article proceeds in parts, each of which is always dealt with by one set of workmen, who, from long practice, become highly efficient in their work. The result of this specialisation and division of labour is that craftsmen can earn good wages, manufacturers make satisfactory profits, and the public can be supplied with articles at convenient prices. Further, as the public taste is changeable, isolated workers are not placed favourably for coping successfully with variable trade conditions.

A few shillings will provide a basket-maker with all the tools which he requires in the pursuance of his craft, so that lack of capital seldom prevents a journeyman from starting independently in business. The multiplicity of small independent firms has led to local competition, which has ultimately killed the trade in certain centres. Had production been carried out on the lines of united effort, the advantages possessed by the foreign manufacturer would have been counteracted.

The large basket-manufacturing firms which exist have been built up from small ones by the intelligence and trade enterprise of their heads. The employees are paid on the piece-work system, the price paid for the making of any article being fixed in many cases by agreement between the employers and the Basket-Makers Trades Union.

In considering schemes for the establishing of Basket-making as a rural industry, it should be understood that the craft demands great skill on the part of its workers. Many years of training are necessary before a workman of average ability can make a high-class article satisfactorily, and a natural aptitude for the work is possessed by the person who becomes a first-class crafts-

man. Even in the making of some of the coarser kinds of basket-ware, under the present system of working long practice is required before a workman can make such articles well, and at the same time earn satisfactory wages.

Basket-making firms situated in willow-growing areas could immediately provide employment to many discharged soldiers. The number could be increased with an increase of suitable orders which the firms might receive. The rise in wages would be very rapid if a sufficient amount of suitable work for these men were obtained. During the past year many cases have occurred in which men not possessing any previous experience of basket-making have been able to make completely certain kinds of Army ammunition baskets after having had a little instruction and a few days' experience, and within a month of commencing such work have earned from £2 to £3 weekly.

Army ammunition baskets in willow are now accepted by the War Office, and small rural manufacturers should apply for orders for such articles; much employment might thus be found for ex-soldiers at remunerative wages. Societies, such as "The Incorporated Soldiers' and Sailors' Help Society" and "The National Association for the Employment of ex-Soldiers" might be induced to establish basket-making works in the villages of the willow-growing districts for the manufacture of Army baskets, and a portion of the funds collected by public subscription in 1914-15 for the assistance of soldiers and their dependants might be used in the same way. Work of this character would give sufficient initial training in the manipulation of rods to enable the workers to continue in the trade at the conclusion of the war.

There is a great annual demand for various kinds of fruit and vegetable baskets in Kent, Worcestershire, and other areas. Merchants and salesmen place orders for them in quantities of thousands at a time. The English maker, even if he could secure an order suitable to the size of his business, could not profitably execute it at the price offered. The majority of these baskets are of foreign make, the business being carried on as a home industry (the members of the family assisting in the making) in a number of villages forming a centre for this class of work. The baskets are purchased by merchants who supply the English markets. Similar methods of production should be adopted in this country if attempts be made to secure this branch of trade. Covent Garden salesmen and others would place orders for baskets direct if the basket-making colonies were sufficiently large to cope with their requirements.

The Nottinghamshire County Council, at the request of a small colony of fruit-growers in the county, recently arranged to supply them with an instructor in fruit-basket making. These growers hope to be able to employ the time during the winter months in making baskets for their own use. Many willows are grown in the neighbourhood, so that a flourishing industry is likely to spring up, able to supply the local demands and to find more distant markets.

A scheme of organisation of basket-making as a rural industry should have in view the linking up of rural workers with large basket-making firms. The latter might be relied upon to assist in the movement by supplying orders for baskets easy of construction, or for the simpler parts of articles which could be completed afterwards by their more skilled workmen. Hosiery manufacturers in some of the large towns of the Midlands employ the labour in the surrounding villages in a similar way.

Where willows are grown on sewage farms it might be possible to induce the local district councils to employ labour in converting the rods into manufactured goods.

If sufficient publicity be given to the subject, capitalists may be forthcoming who would be prepared to found and maintain basket-making establishments, which under proper management might become, in course of time, profitable undertakings.

Firms and Government Departments giving large orders might encourage this industry by giving preference to willow as the working material in cases where its substitution for cane could be accepted.

There are certain branches of the industry suitable to the natural capabilities of female workers. Women excel in the making of the lighter classes of basket-ware, such as casings for bottles, work-baskets, small tables and chairs, and the various kinds of fancy baskets. The upholstery departments of some firms are largely dependent on female labour.

Financial Considerations.—The financial considerations arising out of willow cultivation are set forth in the publication issued by the Board.[2] Some commercial growers, however, consider that the figures for yield and price therein given are too high for an average year on average land. It may be remarked that in the Somersetshire area the rent of willow-growing land is generally between £4 and £5 per acre, and little can be obtained at a lower price. Much of the land in the Trent basin is rented at the same amount. Regarding the profits following good methods of cultivation, Scaling's views express the opinion of the majority of growers at the present

time: "The value of willow crops will range from £10 to £20 per acre according to the state of trade, and the seasons. Occasionally they are worth more than twice that amount. But I should not advise anyone about to plant to base their calculations on extreme profits, lest disappointment ensue. A good return for the outlay may be relied upon in the average of years, and few, if any, crops will give better results."

Weeds, Pests, etc.—The willow crop is subject to damage by weeds, insect and fungus attacks and unfavourable weather conditions. Insects and fungi cannot be dealt with here. Willow lands grow *weeds* profusely owing to the many weed seeds deposited during flood times and the damp conditions favouring their germination. All grasses are harmful, especially when closely intergrown between the heads, owing to the check which they give to the young shoots during the early stages of growth and the general exhaustive effect which they have upon the land. If allowed to remain until cutting time, grass hinders the operations of the cutters, and much of it is conveyed from the ground in the bundles to be an inconvenience during the later stages of preparation of the rods. As "Green" the presence of dead grass in the bundles detracts from their value. More willow beds have become derelict owing to having become overgrown with *Couch* than to any other cause. When once established this weed grass cannot afterwards be completely eradicated owing to the damage done to the stocks of the willows in the cleaning processes. The weed can be kept in check only by the employment of good methods of cultivation. In 1914 a 10-acre bed, planted on the square, containing much couch, was greatly improved by ploughing between the rows in the two directions. The sods were afterwards broken by hand implements and allowed to remain on the ground until dead. This is a new practice. The work was carried out by a careful ploughman, and no harm to the succeeding crop resulted.

Bindweed sometimes grows luxuriantly. By its habit it draws the rods together, thus preventing free growth. The bends induced become permanent, and the rods are then less valuable. It cannot be eradicated, but its effect can be checked by frequent hand weeding.

Cleavers and Nettles by their irritating action cause a roughness to the parts of the rods (usually the basal portions) with which they come in contact. These pimple-like markings are permanent. The weeds can be removed by means of hand implements.

Burnet frequently occurs in pastures in large amount. Its root is thick and long and much weathering is required to kill it. Grass land in which much burnet is present should be well fallowed before being planted. Its harmful effects are due to the overshadowing of the young shoots and impoverishment of the ground.

Rushes sometimes rapidly develop where conditions favour their growth, but improved drainage and surface cultivation will keep them in check.

Adverse Weather Conditions often cause Damage.—Young shoots are very susceptible to attack by late spring frosts. Slight attacks cause a drooping of the tips of the shoots which never afterwards straighten. At cutting time the effect is shown by the presence of double bends in the rods at places a few inches from their bases. In severe cases of attack the growing points are killed and lateral shoots develop from dormant buds situated lower down the stem. A crop of "rough rods" is the result. A case is known where the young shoots were cut off close to the stocks after a severe frost attack. The crop following was of fine quality, but the yield was below the average. Hail storms sometimes bruise the growing rods, and strong winds may loosen the stools.

Economic By-products.—At present the basket-willow yields no by-products which are used economically in this country. The peelings, often accumulated in large quantities, are ultimately returned to the land. Some horticulturists consider them to be valuable in glass-house cultivation as a bottom layer. The bark of the willow is used for tanning purposes in some northern European countries, and results obtained by American investigators show that tannin was present in basket-willow bark in amounts between 6·4 per cent. and 11·38 per cent. according to the variety tested.[4] It is claimed that these amounts are sufficient to make the bark valuable in the leather industry, but it is not stated in the report on the subject that the bark finds a use in this respect. A sample of bark of *Salix triandra* was reported upon by Messrs. Turney Brothers, tanners, Nottingham, as follows:—"It contains only 4·6 per cent. of tanning matters absorbed by hide, and 5·06 per cent. of soluble non-tanning matters. We believe, however, that the tannin has been destroyed almost entirely by mould, as the bark has been exposed to the weather." In this country it has been tested as a material for paper-making and for the making of a leather substitute without success.

It is claimed to have a value in France as fodder, litter, and as mat and sack-making material.[4]

The salicin in willow bark differs in quantity in the different varieties and varies in amount in any variety throughout the year. It is present in maximum amount during the winter months, and rapidly diminishes in quantity when spring growth becomes vigorous. It is valuable medicinally on account of its antipyretic and other properties, and was largely so used until superseded by the synthetically prepared and much cheaper compound—sodium salicylate. The bark of *S. alba* is largely used. Owing to the high price of salicylate of soda, and the interruption in the securing of salicin from the usual sources of supply the question of its profitable extraction from English-grown willows has been considered, and co-operative experiments on the subject between manufacturing chemists, willow-growers, and the Midland Agricultural College are now in progress.

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THE COMPOSITION AND USE OF CERTAIN SEAWEEDS.*

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SEAWEEDS differ from our ordinary land plants in that they are rich in ash, and that the great part of the ash consists of soluble salts of potash and soda. They also contain a small quantity of compounds of iodine, which, in certain species, form a very appreciable proportion of the ash. Kelp, or the ash of seaweed, has long been prepared round our coasts, especially in the poor crofting districts of the West Coast and Islands of Scotland and Ireland. This industry at one time brought large sums of money to the Outer Hebrides, Orkneys and Shetlands, and even in recent times a considerable quantity of kelp has been prepared in certain districts. The industry, however, has always been a badly organised one in the hands of small individual producers who are also crofters and

* Paper read at the Manchester Meeting of the British Association, September, 1915.

fishermen. It has consequently suffered many changes and vicissitudes, and, being unable readily to adapt itself to new conditions, has been little able to contend against the highly capitalised modern industries with which it has come into competition.

The chief products which have been obtained from kelp for many years past have been iodine and potash salts. Kelp, therefore, came into competition with iodine from the Chilian nitrate mines and with potash from the German mines. At present, owing to the war, the supplies of German potash compounds are cut off, and the price of potash has risen enormously. Potash is of importance not merely to agriculture but to various industries, including some of those which supply war materials. There has, therefore, been a revival of interest in the kelp industry, as an industry from which supplies of potash are, to a small extent, being obtained in our own country, and from which greatly increased supplies might be obtained.

The amount of information available as to the composition of different seaweeds and different parts of seaweeds; as to the variation in composition with age, season, locality, etc.; as to the quantities of different seaweeds which can be obtained from given areas; as to the rapidity with which seaweed will grow again if it is harvested; as to the costs of harvesting seaweed and transporting it to suitable centres; and, indeed, all such information as should be obtained before a well-organised industry could be based on seaweed, is very limited indeed. Even such matters as the nomenclature, structure, and physiology of common seaweeds do not seem to be settled with certainty. There appears to be a great field for research on all such subjects.

A good many years ago the writer made a few experiments on the use of seaweeds as manure, and, at the same time, made a number of analyses of seaweed.* After the outbreak of war, when interest again began to be taken in the possibility of utilising these plants for industrial purposes on a large scale, the writer returned to the subject with the help of a grant from the Board of Agriculture for Scotland, under the auspices of which his recent enquiries have been carried out. Two things have been kept in view in such investigations as have been made:—

(1) The possibility of temporary measures to increase the potash supply during the war; and

* The Use and Value of Seaweed as Manure; Trans. Highland and Agricultural Society of Scotland, 5th Series, Vol. X., 1898.

(2) The possibility of improving and extending a permanent industry based on seaweed.

It is interesting to note that for some years back investigations have been conducted in the United States, partly by firms and private individuals, partly by the University of California, and partly by the Department of Agriculture, with the object of obtaining all the information which might be of use, directly or indirectly, in the foundation of industries designed to obtain potash and other useful compounds from the seaweeds of the Pacific Coast, which are known in America as Giant Kelps. The main object is to render the United States independent of supplies of German potash salts. Long before the outbreak of war cut off supplies of German products the Americans set out to try and find such supplies of potash in their own territories as would make them independent of Germany. This wise desire has naturally been intensified by the events of the past year. Though we have had a seaweed industry of a kind in this country for generations, nothing has been done which compares in completeness, manysidedness, and breadth of view with the enquiries into the seaweeds of the Pacific Coast and their utilisation, which are, at present, being conducted in America.

The seaweeds, which are found growing round our coasts in sufficient abundance to be of importance from the point of view of potash supply, belong to two different families :—

(1) Seaweeds which grow between tide-marks, and are commonly known by such names as "black wrack," "cut weed," and "bladder wrack." These belong to the genus *Fucus*, of the Natural Order *Fucaceæ*.

(2) Seaweeds which grow in comparatively shallow water, below low-water mark, and are commonly known by the names "drift weed," and "tangles." These belong to the genus *Laminaria*, of the Natural Order *Laminariaceæ*.

At different periods kelp has been made from seaweed of both these families. In early times, when kelp was made chiefly for its alkali, *Fuci* were largely used. Later, when it was produced as a source of iodine and potash, *Fuci* passed out of use, and kelp was made only from *Laminariæ*. The reason for this change will be made quite apparent by a study of Tables I. to VII.

Seaweeds of both families in the fresh state, but free from adherent moisture, contain 70 to 85 per cent. of moisture. Some of the samples yielding the analyses shown in the tables

had become partly dried while being transported to the laboratory from remote parts of the West Coast and therefore show low percentages of moisture. Seaweeds contain a large proportion of ash, the great part of which consists of salts of potash and soda. The ash, roughly speaking, forms 20 to 25 per cent. of the dry matter. In the case of the stems of *Laminaria* (tangles) it ordinarily forms 30 per cent. or more, but the proportion is not so high in the fronds. In some of the Giant Kelps of the Pacific Coast the proportion of ash found is even higher than in the stems of *Laminaria*.

TABLE I.—*Composition of Laminaria digitata.*

	Maximum.		Minimum.		Average.	
	Stems.	Fronds.	Stems.	Fronds.	Stems, 10 samples.	Fronds, 8 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water	84·56	84·68	75·50	56·88	82·37	74·75
*Organic Matter	16·31	32·66	8·62	9·81	12·31	19·59
Ash Soluble in Water ..	6·78	7·41	3·56	2·64	4·92	4·26
Ash Insoluble in Water, but Soluble in dil. H Cl.	1·94	2·63	0·78	0·68	1·29	1·17
Siliceous Matter ..	0·33	0·42	0·02	0·02	0·12	0·22
*Containing Nitrogen	0·28	0·59	0·15	0·20	0·23	0·34
In Soluble Ash :—						
Potash	2·92	2·51	1·18	0·65	1·83	1·28
Soda	2·95	1·59	0·62	0·36	1·12	1·04
Sulphuric Anhydride..	0·65	1·46	0·37	0·49	0·52	0·76
Total Halogen as Chlorine	2·52	2·54	0·65	0·68	1·73	1·43
Iodine	0·131	0·170	0·072	0·043	0·095	0·095

During the past year a large number of analyses have been made in the writer's laboratory of samples of the common seaweeds collected from different points on the coast of Scotland, nearly the whole of the samples being obtained from the Western Islands and from the Orkneys. The samples were obtained at different times of year, one set of samples being collected in winter, a second in spring, and a third in summer. A summary of these analyses is given in Tables I. to VII. showing :—(1) The composition of the weeds as obtained ; (2) The composition of their dry matter ; (3) The maximum, minimum and average figures found for each kind of seaweed and for each determination made ; and (4) Some of the more important figures as to the composition of the ash of the seaweeds.

Of the different species of *Laminariæ*, *L. digitata* is by far the most important. Next to it in importance comes *L. stenophylla*, which is classed by some not as a separate species, but as a variety of *L. digitata*. As there is some uncertainty as to the nomenclature of different species of *Laminariæ*, it may be said that the name *L. digitata* as here used refers to

the variety figured as *L. digitata* (Lamour) in Harvey's Phycologica Britannica, 1871, plate CCXXIII; and where the name *L. stenophylla* is used it refers to plants more or less closely corresponding to that figured as *L. digitata* (var. *stenophylla*) in Harvey's Phycologica Britannica, plate CCCXXXVIII. All the *Laminariæ* consist of a stem (stipes) and a broad, flat frond or lamina. In the case of the two important species, stems and fronds have been analysed separately, and separate analyses are given for them in Tables I. to IV.

TABLE II.—*Composition of Dry Matter of Laminaria digitata.*

	Maximum.		Minimum.		Average.	
	Stems.	Fronds.	Stems.	Fronds.	Stems, 10 samples.	Fronds, 8 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
*Organic Matter	70·59	86·84	55·81	62·08	64·03	77·28
Ash Soluble in Water ..	30·54	30·96	21·92	12·23	27·98	17·30
Ash Insoluble in Water, but Soluble in dil. H Cl.	11·48	9·32	4·72	2·85	7·37	4·59
Siliceous Matter ..	2·17	1·78	0·11	0·05	0·66	0·82
*Containing Nitrogen	1·64	1·72	0·93	0·77	1·31	1·30
In Soluble Ash :—						
Potash	12·67	9·40	7·00	2·26	10·49	5·25
Soda	7·73	7·86	3·80	1·09	5·35	4·24
Sulphuric Anhydride..	5·49	6·10	2·21	1·89	2·94	2·97
Total Halogen as Chlorine	12·20	12·51	3·87	2·38	9·92	6·11
Iodine	0·649	0·482	0·455	0·280	0·536	0·376

The tangles, which are washed ashore in great quantities in winter, and from which the variety of kelp known as "tangle ash" is made, consist of the stems of *Laminariæ*, and, so far as the writer's observation goes, are composed almost entirely of stems of *L. digitata*. The "May-weed" or "drift-weed," which is cast ashore in immense quantities in spring, consists, on the other hand, very largely of the fronds, which break off naturally at that season. With these are always mixed some stems as well as portions of seaweeds of various other species, but they form only a small part of the whole. From this weed, ordinary kelp is made.

Tables I. and III. show that the stems contain more moisture than the fronds. Nevertheless, they contain more ash and potash than the fronds, and their deficiency in dry matter as compared with the fronds is due to their much lower percentage of combustible organic matter. The stems and the fronds contain, on the average, about equal quantities of iodine.

If we consider merely the dry matter, Tables II. and IV., it will be seen that the superiority in potash of the stems is brought out even more markedly. On the average, the dry

stems contain 10 or 12 per cent. of potash, while dry fronds contain only about 5 per cent. Certain of the Giant Kelps of the Pacific Coast have been found to yield very high percentages of potash in their dry matter. Of our common seaweeds, the stems of *Laminaria* (tangles) appear to be the only ones which approach them in this respect. If tangles were merely dried and ground they would form a manure containing about 10 per cent. of potash, together with about 1 per cent. of nitrogen, and a considerable amount of organic matter. At the present price of potash such a manure would be very valuable, and even in ordinary times it might be worth consideration as a constituent of manure mixtures.

TABLE III.—*Composition of Laminaria stenophylla.*

	Maximum.		Minimum.		Average.	
	Stems.	Fronds.	Stems.	Fronds.	Stems, 4 samples.	Fronds, 4 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water	85·26	81·41	80·50	78·05	83·44	79·55
*Organic Matter	13·35	17·64	9·18	13·83	11·04	15·79
Ash Soluble in Water ..	4·83	4·18	4·40	3·43	4·65	3·74
Ash Insoluble in Water, but Soluble in dil. HCl.	1·45	0·88	0·70	0·81	1·02	0·86
Siliceous Matter ..	0·30	0·17	0·01	0·02	0·11	0·06
*Containing Nitrogen ..	0·25	0·27	0·14	0·17	0·18	0·23
In Soluble Ash :—						
Potash	2·18	1·15	1·68	0·88	1·94	1·01
Soda	0·88	1·10	0·62	0·84	0·78	1·01
Sulphuric Anhydride..	0·37	0·58	0·26	0·33	0·30	0·48
Total Halogen as Chlorine	1·93	1·57	1·60	1·21	1·79	1·41
Iodine	0·098	0·068	0·036	0·050	0·059	0·058

It was found that the samples of *Laminaria digitata* which were collected in the spring and summer were richer in potash than the winter samples. The number of samples analysed, however, was too small for one to base any general conclusions on them. This is a point which deserves further attention, for, at present, tangles are collected mainly in winter.

Table VII. shows the percentages of potash and iodine in the ash of the different seaweeds, and also the proportion of iodine in the ash expressed as pounds per ton. The ash of *Laminariæ* stems is very rich in potash. The minimum in 14 samples analysed was over 20 per cent., and the average about 29 per cent. Even in the fronds, the minimum was about 17 per cent., and the average over 20 per cent. At the present price of potash such ashes would be very valuable even if the iodine were neglected altogether. Potash is, at present, quoted at about 15s. per unit, so that an ash containing 20 per cent. of potash should be worth about £15 per ton for its potash alone. The potash found in the ash of seaweeds is all soluble in water,

and is present almost entirely as a mixture of chloride and sulphate.

TABLE IV.—*Composition of Dry Matter of Laminaria stenophylla.*

	Maximum.		Minimum.		Average.	
	Stems.	Fronds.	Stems.	Fronds.	Stems, 4 samples.	Fronds, 4 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
*Organic Matter	68·45	80·58	61·15	74·38	64·73	77·76
Ash Soluble in Water ..	33·57	21·05	22·57	15·46	29·00	17·84
Ash Insoluble in Water, but Soluble in dil. HCl.	7·42	4·38	4·67	3·87	5·73	4·13
Siliceous Matter ..	1·56	0·84	0·04	0·08	0·53	0·26
*Containing Nitrogen ..	1·26	1·46	0·86	0·75	1·02	1·08
In Soluble Ash :—						
Potash	15·16	5·47	8·55	3·74	12·35	4·49
Soda	6·64	5·70	3·17	4·34	4·91	4·91
Sulphuric Anhydride..	1·91	2·67	1·59	1·69	1·77	2·42
Total Halogen as Chlorine	13·43	7·96	8·21	5·48	11·28	6·56
Iodine	0·501	0·330	0·233	0·236	0·319	0·289

The ash of *Laminariæ* also contains notable quantities of iodine. In this respect it is much more valuable than that from the Giant Kelps of the Pacific Coast which, though very rich in potash, are poor in iodine. The iodine usually amounts to about 0·1 per cent. of the original *Laminaria*, or to about 1 to 2 per cent. of the ash. On the average, the ash of the fronds is rather richer in iodine than the ash of the stems. The iodine is present in the ash in the form of iodides. In the original tissues it is present, to a large extent at any rate, in organic combination. On the average, *L. digitata* is richer in iodine than *L. stenophylla*, both as regards the stems and the fronds. The average amount of iodine in the ash of *L. digitata* was over 33 lb. per ton in the stems, and over 40 lb. per ton in the fronds, and it rose as high as 61 lb. per ton in one case.

Figures as high as these are never obtained in commercial samples of kelp. As a rule, commercial kelp is very impure, and is much lower in both potash and iodine than it should be if it were carefully prepared from clean weed and preserved from deterioration and loss. The ash of *Laminariæ*, and especially of the stems of these seaweeds, is so rich in both potash and iodine that it offers good prospects for the foundation of a permanent industry. An ash containing 20 to 30 per cent. of potash, and 30 to 40 lb. of iodine per ton, should be sufficiently valuable to be worth attention, even when peace returns and the price of potash falls to a normal level. If these seaweeds were collected and dried, and then either burnt or otherwise treated for the preparation of valuable

TABLE V.—*Composition of Chief Varieties of Fucus.*

—	Maximum.			Minimum.			Average.		
	F. vesiculosus.	*F. nodosus.*	*F. serratus.*	*F. vesiculosus.*	*F. nodosus.*	*F. serratus.*	*F. vesiculosus,* 5 samples.	*F. nodosus,* 6 samples.	*F. serratus,* 4 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water	74·15	77·07	78·89	60·40	66·23	71·34	68·17	70·52	75·40
*Organic Matter	30·34	25·75	22·02	21·19	17·41	15·74	25·29	23·13	19·08
Ash Soluble in Water	7·58	5·73	4·75	3·78	4·42	3·83	5·19	4·94	4·22
Ash Insoluble in Water, but Soluble in dil. HCl.	1·93	2·16	1·47	0·55	0·76	0·96	1·06	1·24	1·12
Siliceous Matter	0·39	0·38	0·42	0·07	0·03	0·03	0·28	0·17	0·16
*Containing Nitrogen	0·61	0·39	0·46	0·25	0·27	0·31	0·38	0·33	0·36
In Soluble Ash :—									
Potash	1·23	0·95	1·12	0·71	0·53	0·86	0·97	0·78	1·02
Soda	2·03	2·03	1·25	1·21	1·32	1·12	1·45	1·68	1·18
Sulphuric Anhydride	2·86	1·91	1·14	1·37	1·34	0·91	1·85	1·64	0·97
Total Halogen as Chlorine	1·65	1·23	1·27	0·55	0·83	0·98	1·11	1·01	1·13
Iodine	0·026	0·067	0·019	0·004	0·012	0·008	0·013	0·026	0·012

TABLE VI.—*Composition of Dry Matter of Chief Varieties of Fucus.*

—	Maximum.			Minimum.			Average.		
	F. vesiculosus.	*F. nodosus.*	*F. serratus.*	*F. vesiculosus.*	*F. nodosus.*	*F. serratus.*	*F. vesiculosus,* 5 samples.	*F. nodosus,* 6 samples.	*F. serratus,* 4 samples.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
*Organic Matter	81·94	80·16	80·52	77·14	75·88	74·54	79·71	78·39	77·56
Ash Soluble in Water	19·37	20·37	20·39	14·65	14·95	15·28	16·08	16·90	17·30
Ash Insoluble in Water, but Soluble in dil. HCl.	5·84	6·41	5·13	2·15	2·71	3·84	3·30	4·14	4·53
Siliceous Matter	1·30	1·34	1·48	0·22	0·12	0·16	0·92	0·57	0·62
*Containing Nitrogen	1·54	1·66	2·18	0·80	0·89	1·22	1·18	1·13	1·50
In Soluble Ash :—									
Potash	3·76	3·01	5·28	2·31	1·27	3·43	3·07	2·52	4·18
Soda	5·09	7·19	5·78	3·07	4·38	4·40	4·51	5·78	4·85
Sulphuric Anhydride	7·21	5·83	4·27	4·53	5·15	3·63	5·71	5·46	3·93
Total Halogen as Chlorine	5·02	5·32	6·01	2·11	2·92	3·40	3·44	3·50	4·70
Iodine	0·103	0·238	0·067	0·013	0·032	0·032	0·040	0·088	0·049

TABLE VII.—*Composition of Ash of Seaweed.*

	Maximum.			Minimum.			Average.		
	Stems.		Fronds.	Stems.		Fronds.	Stems, 10 samples.		Fronds, 8 samples.
Laminaria digitata :—	Per cent.		Per cent.	Per cent.		Per cent.	Per cent.		Per cent.
Ash in Weed as received	8·19		10·46	4·78		3·75	6·32		5·66
Potash in Ash	35·62		26·35	20·10		6·80	28·71		20·99
Potash as K_2SO_4	65·86		48·75	37·21		31·10	53·13		54·84
Iodine in Ash	1·810		2·729	1·056		0·762	1·40		1·828
Lb. Iodine per ton	41·64		61·13	23·63		17·07	33·84		40·91
Laminaria stenophylla :—									
Ash in Weed as received	6·15		5·22	5·56		4·31	5·78		4·66
Potash in Ash	39·21		22·03	27·07		17·47	33·60		20·21
Potash as K_2SO_4	73·43		40·76	50·06		32·32	62·38		37·58
Iodine in Ash	1·581		1·577	0·647		0·958	0·995		1·285
Lb. Iodine per ton	35·50		35·33	14·49		21·46	22·31		28·78
	F. vesiculosus.	*F. nodosus.*	*F. serratus.*	*F. vesiculosus.*	*F. nodosus.*	*F. serratus.*	*F. vesiculosus.*	*F. nodosus.*	*F. serratus.*
Fucus :—	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Ash in Weed as received	9·06	8·02	6·64	4·66	5·52	4·88	6·53	6·35	5·49
Potash in Ash	20·82	14·88	20·76	12·35	9·47	16·71	15·29	12·22	18·60
Potash as K_2SO_4	38·54	27·54	38·39	22·86	17·53	30·93	28·31	22·61	34·40
Iodine in Ash	0·558	1·159	0·286	0·069	0·217	0·160	0·225	0·415	0·213
Lb. Iodine per ton	12·50	25·96	6·41	1·55	4·86	3·67	4·59	9·29	4·77

products, under better conditions, with better plant and more efficient organisation than at present, there seems every reason to hope that a permanent and profitable industry might be developed.

The *Fuci* are not nearly so rich in potash and iodine as the *Laminariæ*. Whereas the *Laminariæ*, generally speaking, contain a higher percentage of potash than of soda, and in the ash a higher percentage of halogens than of sulphuric anhydride, the *Fuci* are, as shown in Tables V. and VI., richer in soda than in potash, and their ash usually contains more sulphuric anhydride than halogens—compared with the *Laminariæ* they are very poor in iodine. These differences explain why, when kelp was no longer used as a source of alkali, but became important for its iodine and potash salts, the use of *Fuci* was given up.

In the dried state *Fuci* do not yield nearly so rich a manure as *Laminariæ*. The analyses in Table VI. show that, on the average, they contain only 3 or 4 per cent. of potash when dry, and the maximum found was only 5¼ per cent. in a sample of *Fucus serratus*. The different species were found to vary fairly considerably, *F. nodosus* being poorest in potash and richest in soda, while *F. serratus* was richest in potash. It does not seem likely that it would be remunerative, even at the present price of potash, to dry and grind *Fuci* for manure. In nitrogen they are about equal to the *Laminariæ*.

The important constituents of the ash of *Fuci* are shown in Table VII. On the average, the ash of even *F. nodosus* contains over 12 per cent. of potash, while the minima for *F. vesiculosus* and *F. serratus* are over 12 per cent. It may be taken, therefore, that well-prepared ash made of mixed species of *Fuci* will contain over 12 per cent. of potash, and generally considerably over 12 per cent. It will, therefore, be as rich as, or richer than, the well-known potash manure kainit in this constituent. So long as potash continues at its present price it would probably pay well to dry and burn *Fuci* in order to obtain potash manure. These seaweeds can be obtained in quantity from many parts of the coast, including many sheltered waters from which no great quantities of *Laminariæ* can be conveniently obtained. They can be gathered or cut from the rocks at low tide, whereas *Laminariæ* must be washed ashore by tides and storms, or be cut and gathered from a boat. They can be comparatively easily dried to a sufficient extent to be burned. They do not require complete drying, for once a fire is started its heat completes the drying, and, at the same time, the addition of incompletely dried

weed keeps down the temperature of the fire, which should not be allowed to get too high.

TABLE VIII.—*Analyses of Kelp from Hebrides.*

	Tangle Ash.		Kelp.			
	Good Quality.		Good Quality.		Poor Quality.	
	1.	2.	1.	2.	1.	2.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Mineral Matter Soluble in Water ..	61·99	55·26	59·54	57·04	20·70	31·25
Mineral Matter Insoluble in Water, but Soluble in dilute HCl.	16·97	19·43	28·78	23·06	29·94	29·59
Siliceous Matter	11·67	12·90	6·97	7·84	27·59	15·53
Soluble in Water :—						
Potash	24·05	20·69	21·96	15·10	5·17	8·51
Soda	10·44	8·90	15·85	13·68	2·55	10·05
Sulphuric Anhydride	4·00	4·19	2·68	10·42	8·11	6·65
Sulphur as Sulphide	0·54	0·61	2·26	0·30	0·25	0·12
Total Halogen as Chlorine ..	19·45	21·80	25·67	20·23	1·69	8·84
Iodine	0·90	1·19	0·55	0·67	0·10	0·30

Great quantities of valuable potash manure could be obtained if only the collection and burning of seaweeds, both *Laminariæ* and *Fuci*, could be organised and carried out on a large scale. The available quantities of material are immense, but enterprise and organisation are needed.

A number of samples of kelp produced by crofters in the Hebrides during the season 1914 were analysed during the course of this enquiry, and some of the results are shown in Table VIII. All these are stated to have been prepared from *Laminariæ*, the "tangle ash" from tangles, *i.e.*, stems of *Laminariæ* gathered in winter, and the kelp from "drift weed" washed ashore in spring and early summer. The table shows that the samples vary greatly in quality, and do not contain so much potash and iodine as the samples of the ash of *Laminariæ* prepared in the laboratory (Table VII.). There are a number of reasons for this: (1) All these samples contain considerable percentages of siliceous matter, whereas laboratory samples were almost free from such impurity Owing to the rough methods employed it is not possible entirely to avoid the inclusion of sandy matter in preparing kelp on the large scale, but the large proportions of sand found in most of the samples are quite unnecessary, and indicate more or less carelessness in preparation. (2) The kelp samples contained a certain proportion of carbon and moisture. Laboratory samples were free from these. Samples of kelp should be nearly dry, and the presence of much moisture indicates exposure to damp through careless handling and improper storage. Unfortunately, the poor people who prepare

kelp are often unable to store it properly. (3) Before the weed is burned it is often exposed to wet weather during drying, and sometimes a large part of its soluble salts are washed away before it is burned into kelp. During the process of drying, the weed should be as little exposed as possible to leaching by rain water. (4) If the heat is too great during burning, and especially if silica and lime are present, iodine, and to a limited extent, potash, are apt to be volatilised and lost. A part of the potash may also be fused into silicate under such conditions.

Seaweeds are used, to a certain extent, as food for human beings, and in the crofting districts of Scotland and Ireland as food for stock. Dulse (*Rhodymenia palmata*) is used to a small extent as human food or as a relish to food, both in the fresh state and dried, all round the coasts, and not only in the crofting districts, but it is only in the poorer districts that seaweed is used as food for stock. When in the west of Lewis the writer had an opportunity of making some observations on the seaweeds which were eaten by stock. Both cattle and sheep came down to the beach at low tide of their own accord and ate seaweed. A number of ewes, accompanied by their lambs, were observed. The ewes all ate two varieties of seaweed only. These were Dulse and *Alaria esculenta*. Some of the ewes appeared to eat Dulse only, others ate both weeds freely, but not one of them was observed to eat any other seaweed but these two. Dulse often grows on *Laminaria* stems. The sheep ate Dulse off the *Laminaria* stems, but did not eat the *Laminaria*. The lambs did not eat any seaweed.

The cattle were observed also to eat two varieties of weed only, namely *Laminaria stenophylla* and *Alaria esculenta*. Though there were heaps of *L. digitata* lying on the shore they merely turned it over with their muzzles till they found a piece of *L. stenophylla* or *Alaria*, which they at once ate. They were not once observed to eat *L. digitata*, though this species and *L. stenophylla* so closely resemble one another. Also, when they ate *L. stenophylla* they ate the frond only.

Some of the crofters were on the beach at lowest tide gathering fresh seaweed from the water into creels. They stated that it was for the cattle. The variety they were gathering was entirely *L. stenophylla*, which they said was very good for the health of the stock. They gathered both stems and fronds.

In Table IX. are given analyses of seaweeds used as food, made by the ordinary methods used for feeding-stuffs. Though

there was plenty of *L. saccharina* on the beach neither cattle nor sheep were seen to eat it, but as it was stated that they eat it also, a sample was analysed. The analysis of Dulse is taken from a paper which the writer published in *The Agricultural Students Gazette*, Vol. VI., p. 129, 1893. This sample was obtained from the neighbourhood of Oban. The other samples, analyses of which are given in Table IX., were gathered from the place where the cattle and sheep were observed eating seaweed in Lewis.

TABLE IX.—*Feeding Stuff Analyses of Seaweeds.*

Kind of Weed.	From West Coast of Lewis.			From Oban.
	Laminaria stenophylla.	*Laminaria saccharina.*	*Alaria esculenta.*	*Rhodymenia palmata* (Dulse).
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	81·41	85·38	82·06	78·20
Ether Extract (Oil, etc.)	0·21	0·16	0·23	—
Albuminoids (N × 6·25)	1·69	1·32	1·56	4·61
Soluble Carbohydrates, by difference ..	10·74	6·50	10·43	13·01
Fibre	1·19	0·97	1·15	0·61
*Ash	4·76	5·07	4·55	4·57
	100·00	100·00	100·00	100·00
*Containing Siliceous Matter	0·05	0·44	0·07	0·05

SOME METHODS OF ADDING TO OUR FOOD SUPPLIES.

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IN their final report the Departmental Committee for England and Wales on the Home Production of Food insisted on the great need of increasing the productivity of the soil in this country. To anybody who has studied the conditions of farming at all closely in the southern half of Wales and in the south-west of England generally it is at once patent that all schemes that aim at increased production should also make for enhanced soil fertility.

It may, therefore, serve a useful purpose to inquire into the more obvious limiting factors which militate against increased productivity, and to show how they might be remedied. The matter brought forward, and the suggestions made, in the present article are based in particular on observations made and upon work done on the considerable areas in North Devon and in Wales which range in elevation from about 350 ft. to 800 ft.; they doubtless apply, however, with equal force to some other localities at even lower elevations. At the altitudes mentioned the

activities of the plough are inconsiderable, and consequently the degree of soil fertility is reflected in, and largely determined by, the condition of the grass land.

The chief causes of the inferior condition of the grass land and the consequent infertility of the soil are, probably:—

1. The passing of the universal practice of liming.
2. Insufficient and improper use of phosphatic manures.
3. The exhausting nature of the rotations in common practice.
4. Lack of appreciation of the real value of clovers.
5. Excessive use of rye grass in seed mixtures.
6. The confining of rotation land to one part of the farm; and the length of the rotation.

Each of these causes is reviewed, in turn, and general recommendations for improvements are made in the summary at the end of this article.

It is, of course, realised that some of the methods of improvement suggested, although desirable, may in many cases not be practicable owing to the difficulties connected with labour and transport during the War. In many instances, however, these difficulties may not be insuperable, and it would be better to adopt measures likely to produce lasting benefit than such as would have only temporary results.

1. **The Passing of the Universal Practice of Liming,** and

2. **Insufficient and Improper Use of Phosphatic Manures.**—There are great numbers of farms in Wales, and in Devonshire and elsewhere in the western counties, which have not received a load of lime for 20 years or more, not, indeed, since the lime kilns along these coasts ceased to work. It is, however, a well-known fact that to obtain good grass land the soil must have a sufficiency of lime and phosphates—the two ingredients which are commonly lacking in the soils of the west and which are so much removed by growing animals. Lime is not prohibitive in price: it is obtainable at most stations in Wales and Devonshire at a price ranging from 10*s.* to 24*s.* per ton. It is interesting to observe that liming is still a fashion peculiar to certain parishes and districts; while in other centres where the agricultural conditions are precisely the same the practice has gone entirely out of use. Moreover, it does not appear that there is usually any particular reason for this, the railway facilities being no better or no worse in the one locality than the other. One reason for the decreased use of lime appears to be the very general belief amongst farmers that basic slag sufficiently takes its place, a belief that cannot be substantiated in the case of soils inherently poor

in lime. Both lime and phosphates are much misused. Where lime is employed it is frequently applied to excess, especially on grass land. There is no justification for this, for on much grass land the bagged limes may be used with equal success, whilst a number of farmers find no trouble in applying quicklime with a manure distributor. The best time to apply lime for the benefit of the grass is, however, in the rotation before the land is put down.

With regard to phosphates, there is no doubt that superphosphate often produces good and quick results on grass land, even on soils where lime is deficient; but such results are not lasting, and by further exhaustion of lime make for ultimate infertility—an infertility that will manifest itself in the form of "finger and toe" in a subsequent root crop. A large number of farmers on these soils use superphosphate to the exclusion of basic slag, and have done so for a decade without resort to as much as a bag of lime. Further, in recent times, there has been a growing tendency amongst these farmers to use sulphate of ammonia instead of nitrate of soda—a tendency which will increase on account of the present shortage of nitrate of soda and the facilities given for obtaining sulphate of ammonia at a reasonable price. The result of this excessive use of superphosphate and growing use of sulphate of ammonia is, of course, to deplete the already inadequate supply of lime in the soil to a degree incompatible with reasonable fertility.

It has been sought to emphasise the fundamental need of lime in the west; the remedy must take the form of awakening the farmer to this need and then bringing the lime as near his door as possible; for it is the cartage that he *considers* prohibitive. The means whereby these difficulties may be overcome are discussed in the summary.

3. **The Exhausting Nature of the Rotations in Common Practice.**—It is a remarkable fact that whereas the husbandry in the west is grass land husbandry, yet the average farmer when arranging his rotation thinks less of the effect of the rotation on his subsequent grass than he does of the other crops that he expects his rotation to yield. This is all the more regrettable when, as likely as not, he will leave his seeds down for from four to eight or even more years. One type of rotation is:—Corn; corn; roots; corn; seeds; that is to say, in four years three corn crops and one root crop, save only the leaves, are removed from the land. If adequate manures are supplied in the rotation a good ley may be obtainable for three to four years, provided the ley itself receives proper attention, but deterioration of the sward cannot long

be postponed. The chance of securing a successful ley would be much enhanced if somewhere in the rotation catch cropping and consequent folding on the ground were resorted to. It would be a gain if, with the first corn crops, broad red clover and a little Italian rye grass were sown; this would provide some valuable autumnal grazing and also husband soil fertility. It would be advantageous, also, to put the seeds for the ultimate ley in with a light sowing of rape instead of with barley or oats. The gain is twofold: (1) the final crop in the rotation is returned to the land for the benefit of the "seeds"; and (2) rape need not be sown until June, so that there is a prolonged chance of obtaining a good and clean* tilth for the "seeds," and of getting them in under the most favourable seasonal conditions. The complete failure of leys at high elevations is frequently due to a foul seed bed and bad weather conditions.

There is now being brought under the plough a certain amount of heath land and of outrun grass, all of which will probably in a few years' time again go down to more or less long-duration grass. It is an unfortunate fact that heath land broken up to yield a few crops and then put down to grass under existing methods, deteriorates very rapidly, becoming completely overrun with bent (*Agrostis vulgaris*), and remains for a number of years of less value than the normal fescue pastures of the heath. It will, indeed, be a tragedy if much land broken up to meet the needs of the present crisis is allowed ultimately to revert to something as bad as, or worse than, the original. To the long-sighted farmer, however, now is a golden opportunity to plough up outrun grass land and heath land; he should not only keep in view the production of corn or other immediately available foodstuffs, but his aim all through the rotation should also be to accumulate fertility for the benefit of his coming grass. Unless this is generally done, the nation will lose rather than gain in proportion to the amount of land so broken.

4. **Lack of Appreciation of the Real Value of Clovers.**—The great majority of farmers in the regions under discussion look upon the clovers merely as a food, desirable food it is true, for stock. Professor Somerville† has convincingly proved the value of clovers as conservers of fertility, and properly understood this is their greatest value. In order to succeed, clovers must have a sufficiency of phosphates and lime, and to husband fertility they need

* That is to say, the farmer has ample opportunities to harrow and get the annual weeds to germinate and then to harrow them out.

† Somerville, W., Accumulated Fertility in Grass Land, *Jour. Board of Agriculture*, Vol. XXI., September, 1914, p. 481.

to be ploughed down while still abundant on a field. In practice these conditions are by no means fulfilled, the leys being broken up when partially or wholly outrun; indeed, they are so treated *because* the clovers have dropped to nothing. An obvious method is to shorten the rotation, and do away with long-duration leys; this, however, spells a return to arable farming proper which, to any extent, will be an after-the-war and not a during-the-war expedient.

The aim of the farmer in the western counties should be to encourage his clovers to persist for a reasonable length of time, and this he may do in several ways, provided always that he uses lime and phosphates. With regard to red clover he should on no account purchase South American seed, but should insist on having seed of English or Welsh growth (grown at as high an elevation as possible). Such seed will often be dull in appearance, may contain rather much rib-grass, but if free from docks and wild carrot should be accepted if it germinates over 90 per cent. A part at least of the red clover included in the mixture should consist of the relatively lasting "Late Flowering Red Clover." The only clover that will really last for six years and upwards, however, is white clover. On many soils, if the ley is properly treated and a phosphatic manure (in the generality of cases basic slag) is applied in the autumn after the covering crop is removed, and again subsequently, white clover will grow naturally and persist in proportion to the proper management of the field. If it is found that, despite an ample use of phosphates and even when commercial white or Dutch clover* is sown, white clover does not come in or persist on a farm, then, expensive as the seed is, resort should be made to the use of Wild White Clover.†

A good development of clovers (especially white clover) early in the life of a ley is the surest way of obtaining a good bottom to, and a prolonged subsequent grazing from, a prepared pasture, for these leguminous herbs add immediately to the fertility of the soil and encourage the meadow grasses, crested dogstail and other valuable and lasting indigenous grasses.

In Wales and in many parts of North Devon above about 500 ft. trefoil is as elsewhere largely sown, but at these altitudes it seldom does well. The plant that actually appears and succeeds

* Failures when commercial Dutch clover are sown are frequently due to the inferior seeds purchased. This seed has become very expensive, and consequently cheap samples contain much old and "hard" seed, and, as well as weed impurities, quantities of trefoil and yellow suckling clover. See p. 1046.

† See article on Wild White Clover, p. 1063.

is not trefoil (*Medicago lupulina*) but the indigenous yellow suckling clover (*Trifolium minus*). The misguided use of trefoil in these districts involves in the aggregate a considerable annual waste of money.

5. **Excessive Use of Rye Grass in the Mixtures.**—The practice of sowing something like a bushel of rye grass, with no other grasses or only a little cocksfoot and timothy, together with clovers, for a long duration ley is still all too prevalent in the west.* Yet this practice, in conjunction with the continual taking of hay for the first two, three or even four years in the life of a ley, is probably responsible for the rapid deterioration of innumerable fields. Matters are worse when the hay is regularly cut too late in the season. Yorkshire fog and even bent (or fiorin) are then allowed to ripen their seeds, which fall to the ground abundantly during harvesting, and year by year produce an accumulative deterioration of the herbage—a deterioration which is the more pronounced since the rye grass falls off rapidly after the second year and leaves little or nothing to compete with the upstart fog and bent.

If they are to be a success, mixtures for long-duration leys should be reinforced with fair quantities of cocksfoot, timothy, and crested dogstail in particular, with a corresponding decrease in the amount of rye grass. If the general practice were to sow never less than 6 lb., and preferably 8 lb., of cocksfoot to the acre and never more than 14 lb., and preferably 10 lb., of rye grass instead of the 1 or 2 lb. of cocksfoot and 18 lb. to 26 lb. of rye grass, the gain in the productivity of the grass land in the regions under review would be both lasting and material.

6. **Confining the Rotation Land to one part of the Farm; and Length of Rotation.**—The rotation practised in districts most essentially devoted to grass land is a long one. The leys are frequently left down from four to six years, and often as long as eight to twelve years. This is an important point when estimating the condition of the grass land in any district, for usually the leys, especially at the higher elevations, deteriorate rapidly after they have been down more than two or three years.

Some light is thrown on this question by figures obtained and observations made by the writer in connection with a botanical survey now in hand of the district behind Aberystwyth. In dealing with the main cultivated tract up to 600 ft. above sea level

* Such a mixture when used on good soils freely manured, especially with phosphates, will sometimes give a good long-duration ley, because under these conditions valuable indigenous grases soon come in naturally; on poor soils, however, this is not the case.

(as opposed to the heath and mountain tracts) it has been found expedient to classify the cultivated land as follows:—(*a*) Cultivated land proper, *e.g.*, land actually under corn or roots, or under well-tended leys (judged by botanical criteria): in practice such leys are in their first or second year, or even in a third or fourth year, if under the influences of good management they retain the impress of cultivation so long; (*b*) Outrun leys, *i.e.*, leys which have largely reverted to a relatively poor and indigenous herbage: in practice these are fields which have been down to grass from three to twelve years; (*c*) Permanent grass proper (judged by botanical criteria): in practice these have been down for 20 years and upwards, and occur in greatest amount at relatively low elevations. The area surveyed is typical of thousands of acres in the west, and hence the following figures showing the acreage under each of the foregoing types are suggestive:—

	Acres.		*Per cent.*
(*a*) Cultivated land, including tended leys	6,315	..	40·9
(*b*) Outrun leys	5,760	..	37·4
(*c*) Permanent grass	3,340	..	21·7
	15,415		100·0

The relation of these types of land (as judged by botanical criteria) to each other may be expressed thus:—

Cultivated land, including tended leys : Outrun leys and permanent grass :: 1 : 1·4

The above statements illustrate very well to what an extent the long rotation is practised in the west. The significance of this is, of course, to be seen in the high ratio the outrun leys bear to permanent grass proper, and this is the more striking when it is realised that the productivity of the permanent grass is considerably better than that of the outrun leys. It is, therefore, the acreage reached by outrun leys that unfortunately affords the surest criterion for estimating the fertility of the soil in Wales and in the western counties generally.

There is, moreover, good evidence to show that by far the most productive of the three categories under which cultivated land has here been classed is, "Cultivated land proper, including tended leys." The poor productivity of outrun leys is apparent by reference to the stock-carrying capacities of carefully selected farms.

Mr. Pryse Howell, who is engaged upon the economic aspects of the survey referred to, has ascertained the stocking of a num-

ber of farms and has reduced these to a single factor expressed in terms of sheep per acre, and owing to his kindness the following statement can be given.*

Six farms at about equal elevation, on which sheep and cattle were kept through the winter, the sheep also having access to the "ffridd," or lower parts of the mountain walks (which were of similar botanical characteristics in each case), were averaged in pairs, and may be grouped thus:—

(*a*) Cultivated land, including tended leys : outrun leys : : 69 : 31
gave a winter stock factor of **1·94.**

(*b*) ,, ,, including tended leys : outrun leys : : 36 : 64
gave a winter stock factor of **1·43.**

(*c*) ,, ,, including tended leys : outrun leys : : 25 : 75
gave a winter stock factor of **1·2.**

More exaggerated cases might have been quoted, but care has been taken to select farms equal in every respect, except for the ratio of cultivated land proper (including tended leys), to outrun leys. These examples, however, with what has already been said, should serve to emphasise what is of the utmost importance at the present time, viz., that crop production increases the stock-carrying capacity of a farm. This statement, however, requires slight qualification, for a study of the methods of husbandry practised, and of the nature of the pastures on farms largely under grass, shows that the aggregate productivity of the land in grass is nearest its maximum when the rotation is carried over the whole farm (with the exception of the real permanent grass), provided always that farmyard and phosphatic manures are sufficiently applied. In such circumstances the gain is greater when no fields are allowed to be down to grass for more than about 4 years than when a more intensive rotation (receiving the same amount of manures and producing the same acreage of crops per annum) is practised on one corner of the holding to the exclusion of the rest. To obtain maximum productivity, therefore, it is desirable to compromise between shortness of rotation and size of holding, and if necessary to obtain all the arable crops that available labour permits of by taking a comparatively long rotation regularly over the whole farm. When, however, expediency dictates a relatively long rotation it is essential that the early cropping should be in part subservient to the subsequent ley, and, further, that a good mixture be used and the ley itself manured.

Summary and Conclusions.— It has been the burden of the present article to show the more obvious defects in the methods upon

* The stock factors are somewhat tentative, the economic survey being only in its initial stages; all the evidence collected, however, goes to show that further investigation will tend to confirm what is here said.

which the system now in vogue depends, for the system cannot be immediately altered, though by energetic action the methods can be rapidly improved. Again, in proportion as a proposed system is complicated, it is necessary that the bed-rock methods of farming should be sound.

It is now generally realised that fundamental alterations cannot be made in our systems of agriculture during the War. After the War improvements in the husbandry on the more elevated regions of the west are almost certain to aim at increased cattle production rather than at the augmentation of our cereal or other food supplies.

Liming.—The writer is of opinion that no substantial improvement is possible in hundreds of parishes in the west until regular liming is reintroduced, and he would be a bold man who would plead for an introduction of continuous cropping, largely dependent as it is upon cruciferous plants, into a district where the practice of liming had completely lapsed.

It is, of course, realised that applications of lime cannot be expected to add materially to the fertility of a soil until after the lapse of 12—18 months. It is equally obvious, however, that immediate expedients for adding to our current food supplies must largely turn on a further use of sulphate of ammonia and on a guarded resort to more intensive cultivation—that is to say, on measures which tend to aggravate a shortage of lime in the soil. It must also be borne in mind that the contribution of the western counties to our resources is to be reckoned chiefly in terms of live stock, supplies of which are not at all likely to become superabundant immediately after the termination of the War. For these reasons current war measures which run counter to the available lime in a district are short-sighted, but such measures, in conjunction with efforts to put the lime requirements of the soil right, spell both immediate and lasting benefit.

In view, moreover, of both the uncertainty as to the duration of the War and our now overwhelming naval supremacy, it may be justly claimed that measures adopted to meet our immediate needs, if they also rob the soil of subsequent fertility, are not justified. Further, any rational improvement put into operation this tillage season, although possibly not adding to our supplies during the War, will tend, nevertheless, to curtail imports at a time when it will be just as important as at present to husband our internal resources.

The chief obstacle in the way of the reintroduction of liming, especially in the more remote parishes, is the difficulty connected

with cartage. Labour has also been getting scarcer for a number of years. Consequently, the old fashion of liming has almost of necessity lapsed.

The introduction of artificial manures is largely responsible for this: "artificials" have become the fashion, they frequently give an obvious return, and on account of their relatively slight bulk may be brought on to the farm in sufficient quantity without repeated journeys to the station. It is a commonplace, however, that people may be induced to purchase all manner of commodities if they are sufficiently urged to do so, and if the wares are brought to their door. It only requires organisation to bring lime to the farmer, and under these conditions not much persuasion to induce him to purchase it.

A lightning survey should be made of the non-calcareous soils in the west, and the districts mapped where the practice of liming has lapsed and where it should obviously be reinstated. The War Agricultural Committees or other authoritative bodies, such as the Agricultural Organisation Society or National Farmers' Union, should then arrange an active lime propaganda in the districts indicated. Lectures might be given, and every farmer visited and asked how much lime he would purchase, delivered at the nearest possible point to his farm. The lime requirements for a county having thus been ascertained, a responsible central body might arrange for its purchase in bulk and delivery in required amounts at the most suitable railway stations for each district.

The greatest difficulty to be encountered would, however, be the conveyance of the lime from certain railway stations to inaccessible farms. Local organisation could possibly arrange for this. In some districts delivery could doubtless be facilitated by the use of motor lorries, and in any event local energy would probably be competent to solve the problem for the various parishes needing assistance. *Now* is the time to consider such schemes as this, so as to pave the way for that extensive agricultural development for which we all look in the near future.

Improvement in Seeds Sown.—Other glaring causes of infertility have been shown to be connected with the quality and kind of seeds most usually sown.* Much can be done and has been done by bringing farmers to appreciate this, but more could be accomplished, and infinitely more rapidly, by directly approaching the local vendors; and, again, *now* is the golden opportunity for doing this. Like every other Briton, the local vendor of seeds

* See also this *Journal*, pp. 1041–1062, as to seed testing.

is a patriotic man. Every single tradesman and co-operative society selling seeds in Wales and the West of England should be approached by somebody having a thorough knowledge of seeds and of the requirements of the various districts in question. West of England and Welsh farmers are addicted to using cheap seeds, but they can be persuaded to buy better ones, and the salesman can be relied upon to do the persuading, provided he can place the responsibility for possible failure on other shoulders. The vendors could also do everything to introduce reasonable mixtures into their districts, provided they knew what are reasonable mixtures. They could also encourage the sale of rape and the seeds of other catch crops, and they should be made to see the futility of supplying poor seeds of crops which it is to their advantage to introduce successfully.

Change of Rotation.—The need of shortening the rotation has been emphasised, but under existing conditions of scarcity of labour not much is at present to be hoped for in this direction.

In regard to moving the rotation over the whole of a farm, the chief drawbacks are lack of water and the difficulty of carting farmyard manure to inaccessible fields. Resort to catch cropping and folding can to some extent obviate the second difficulty. It is, however, often within the power of the landlord materially to help the tenant by arranging for water facilities. He may also erect cattle houses within reasonable reach of the fields whereby manures can be dealt with more or less on the spot.

Catch Cropping.—Ultimately, when auto-driven machinery has become more perfected, it is not unlikely that a considerable extension of the Wibberley system of continuous cropping* will find favour in this and other stock-raising districts.

Many of the recommendations which have been brought forward may appear to some to be too impracticable to be put into immediate operation. Their feasibility, however, depends almost solely on an organised expenditure of energy and good will. All will agree that if such obvious bars to reasonable fertility as lack of lime and phosphates and use of inferior seeds were successfully combated, the productivity of hundreds of farms in Wales and the West of England might be doubled, and in some instances trebled. Until this is done it is well-nigh useless to talk of revolutionising the systems of agriculture there practised, and endeavours to improve the quality of the live stock, however successful, amount at best to putting the cart before the horse.

* Modified, if necessary, to suit the needs of every characteristic district.

The data drawn upon in section (6) of this paper have been collected on behalf of the Agricultural Department of the University College of Wales, Aberystwyth, in connection with an extensive botanical, geological, and economic survey. A full report on this survey will be published by the College in due course. Thanks are due to Mr. Pryse Howell for much valuable information in the preparation of this article.

A NEW FUNGICIDE FOR USE AGAINST AMERICAN GOOSEBERRY-MILDEW.

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Introductory.—Since the introduction of the American gooseberry-mildew (*Sphærotheca mors-uvæ* (Schwein.) Berk.) into this country some 10 years ago and its subsequent establishment in all the fruit-growing centres, numerous investigations have been made to ascertain the best means of dealing with this serious pest both in summer and in winter. It may now be regarded as proved that thorough spraying with the lime-sulphur wash in May and June before the "summer-stage" of the mildew* has reappeared on the young shoots is a practicable, commercial method of protecting gooseberry bushes early in the season.† On many large fruit-farms this spraying with lime-sulphur in the spring is becoming a regular feature in the routine of the cultivation of the gooseberry. Also, researches which have been carried out into the life-history of the mildew have shown the necessity for the early removal and burning of the "winter-stage" at the end of August or beginning of September, in order to prevent the infection of the soil by the "fruit-bodies" containing the "winter-spores."‡ If such contamination of the soil occurs, a sudden and virulent infection of the young gooseberries on the lower branches of the bushes is liable to occur, in spite of all spraying.

The one commercial disadvantage of the lime-sulphur wash is the remarkably adhesive deposit which it leaves on the berries when they are sprayed, so that those which have been heavily sprayed must either be mechanically rubbed against each other

* A fully-illustrated Leaflet giving the life-history of the American Gooseberry-mildew can be obtained free on application to the Secretary, Board of Agriculture and Fisheries, Whitehall Place, London, S.W.

† E. S. Salmon: *Journ. Board of Agriculture*, March, 1914; *Journ. South-Eastern Agricultural College*, XXI, 394 (1912), and XXII., 403 (1913).

‡ E. S. Salmon: *Journ. Agric. Science*, VI., Part II., May (1914).

under water, or passed through a machine, such as the Fletcher and Becker "Gooseberry Cleaner." If the gooseberries are to be marketed while green, considerable disadvantage may thus attend the use of lime-sulphur, and consequently it has been generally recommended that a solution of "liver-of-sulphur"—which leaves no visible deposit—be substituted for the lime-sulphur wash at times when there is a danger of disfiguring the crop for market.

During the past two years special attention has been devoted in the Research Department of the South-Eastern Agricultural College to the means of controlling, by the use of fungicides, the class of fungi (*Erysiphaceæ*) to which the American gooseberry-mildew belongs, and a large number of carefully-controlled experiments have been conducted. The full details of these investigations will be recorded in the next issue of the *Journal of Agricultural Science*, but the practical value attaching to certain of the results obtained makes it desirable to bring them to the notice of growers immediately. It may be stated at once that these experiments have demonstrated: (1) the inefficacy of the "liver-of-sulphur" solution; and (2) the value of a new fungicide, viz., ammonium sulphide, having special properties which make it worthy of trial by the commercial fruit grower.

Methods.—The main series of experiments referred to was conducted with the hop-mildew (*S. Humuli*), which was sprayed with solutions of different fungicidal substances, and then carefully observed at short intervals. The work was then extended, as regards the main features tested, to include the American gooseberry-mildew. The method of research was briefly as follows.

The hop plant (a young seedling) was carefully selected as bearing on a number of its leaves numerous young and vigorous patches of the mildew in its *conidial* or summer-stage. Only those patches of mildew were used in which the growth was such as to have produced the densely "powdery" patches so characteristic of the mildew when rapidly spreading under favourable conditions. The solution to be tested was applied in an extremely fine spray by means of a hand "atomiser," sufficient force being used to ensure the thorough wetting of each patch of mildew; "control," *i.e.*, unsprayed, leaves with patches of mildew in the same stage were always present on the same plant. The sprayed leaves were regularly observed from the first day after spraying until the final effect of the solution was observed.

Experiments with Liver-of-Sulphur Solutions.—The first fact of practical importance which was noted was that solutions of liver-of-sulphur, and similar substances, even when applied in a very fine spray, are unable to wet uniformly patches of mildew in the powdery "summer-stage." This fact is due to the presence of air between the separate *conidiophores*, and also between the ripe, detached *conidia*. Aqueous solutions of liver-of-sulphur and similar substances when sprayed on these densely aggregated masses of *conidiophores* and *conidia* collect in minute drops on the surface of each patch of mildew, and will not penetrate it until the wetting properties of the solutions are increased by the addition of a solution of soft soap. From the results observed it is obvious that the use of such sprays without the addition of soft soap should be discontinued.

An extended trial was made of liver-of-sulphur solutions, of various concentrations, with soap, because of the statements which have been made by many investigators as to their efficacy against these mildews in general and against the American gooseberry-mildew in particular. The formula recommended by European mycologists generally is 1 oz. of liver-of-sulphur to 2 or 3 gal. of water, *i.e.*, a 0·31 to 0·21 per cent. solution, while that favoured by American mycologists (making an allowance for the difference between the American and the English gallon*) is a 0·37 to 0·25 per cent. solution. In the United States, in particular, many investigators (*e.g.*, Goff, Close, Beach, Halsted) have stated that these solutions of liver-of-sulphur have proved fungicidal against the American gooseberry-mildew.

Liver-of-sulphur is not a definite chemical compound and is known to chemists to vary very considerably in composition. This fact has recently been brought to the notice of growers in a striking manner in this *Journal*,† and it will be seen that to recommend a particular percentage of this substance may be very little guide as to the usefulness of a wash. When testing the value of liver-of-sulphur as a spray-fluid we have used a freshly prepared sample which was chosen because of its very high sulphur content, viz., 44 per cent., of which 42 per cent. was in the form known as sulphide sulphur; so that it may be considered a superior sample to anything likely to be purchased by the grower.

In the writers' experiments with the hop mildew, repeated trials with a 0·3 per cent. solution of this liver-of-sulphur (prepared so as to contain 1 per cent. of soft soap) showed invariably that at this concentration it was *not fungicidal*; the patches

* The English gal. weighs 10 lb.; the American gal. 8·345 lb.
† Vol. XXI., 1914, p. 236.

of mildew were more or less checked for the first few days, but, by about the third day after spraying, a fresh growth of the mildew had taken place, and by the fifth to eighth day after spraying, the patches were as "powdery" as they were before. The mildew was greatly checked by a 0·6 per cent. solution of this liver-of-sulphur, but occasionally it recovered completely; at a concentration of 0·8 per cent. the solution was either completely, or almost completely, fungicidal.

The same result was obtained when a 0·3 per cent. solution of this liver-of-sulphur (with 1 per cent. of soft soap) was used against the summer-stage of the American gooseberry-mildew. A gooseberry shoot severely affected was sprayed thoroughly, using a hand "atomiser"; 7 days afterwards the mildew was as vigorous as before the spraying.*

It seems clear from the above results that the use of solutions of liver-of-sulphur of the strengths generally recommended must be discontinued as being mere waste of time and money. It may be noted here that it is the practice of some hop-growers to add a 0·10 to 0·15 per cent. solution of liver-of-sulphur to the "hop-wash" against *Aphis* in the belief that this will combat the "mould" or mildew. In order to make this substance fungicidal it would be necessary to increase the concentration to a 0·8 per cent. solution containing 0·35 per cent. of sulphur, and while this does not appear to cause injury to the hop-leaf, it is probable that a solution of this strength would cause injury, in the form of "scorching," to the tender parts of the hop plant, such as the tips of the shoots, the young leaves, and the "pin" (young flowering shoot). Whatever may be true in the case of the hop, it is certain that a liver-of-sulphur solution of a fungicidal strength, *i.e.*, 0·8 per cent. cannot be used on the gooseberry. A solution of 0·4 per cent. used in some field experiments by one of the writers in 1914† caused serious injury to the tips of the young shoots and to the young leaves. In some field experiments carried out under the writers' directions last summer by Mr. C. W. B. Wright, in Midlothian, and at Kinnaird, Perthshire, a 0·4 per cent. solution of liver-of-sulphur (containing 44 per cent. of sulphur) caused the same kind of injury to the leaves and growing points of the young shoots of "Whinham's Industry." Further, as has often been noted by investigators, the use of even the 0·3 per cent. solution will sometimes cause "scorching" injury, resulting in a more or less serious leaf-fall. It would appear, therefore, that for the control of the American goose-

* See below, p 1122.

† E. S. Salmon: *Journ. South-Eastern Agric. College*, Vol. XXII. (1913).

berry-mildew liver-of-sulphur solutions must be discarded entirely.

Experiments with Ammonium Sulphide Solutions. — Ammonium sulphide was then used as being a substance leaving no visible deposit, and therefore not disfiguring the gooseberry crop. A stock solution of this was prepared which contained 3·7 per cent. of sulphur, of which 2·2 per cent. was in the form of sulphide sulphur. From this solution various washes were prepared by diluting with water, and adding soft soap so that the final wash contained 1 per cent. of soft soap solution.

A solution of ammonium sulphide containing 0·13 per cent. of sulphur was found to be almost, or quite, fungicidal; when containing 0·22 per cent. of sulphur the solution proved invariably fungicidal.

After obtaining the above results in repeated experiments with the hop mildew, solutions of ammonium sulphide were used against the American gooseberry-mildew in two experiments in the open. In July, 1915, a row of young gooseberry bushes, most of the young shoots of which were densely smothered with the mildew in a very "powdery" condition, was treated as follows:— (1) Six affected shoots were sprayed with a solution of ammonium sulphide containing 0·13 per cent. of sulphur and 1 per cent. of soft soap; and (2) six similarly affected shoots were sprayed with a solution containing 0·26 per cent. of sulphur and 1 per cent. of soft soap. The remaining affected shoots were left unsprayed as "controls." A close examination made twelve days afterwards gave the following results:—In the case of (1) the mildew on four out of the six shoots had been reduced by the spraying to a completely barren and dying condition; one shoot showed a few scattered *conidiophores* on the patches on two leaves; and one shoot showed several minute, almost "powdery," patches on two leaves. In the case of (2) the *mycelium* of the mildew was completely barren and becoming disintegrated on all the six shoots. The mildew on all the control shoots was vigorously growing and densely "powdery."

In the second experiment two mildewed shoots on the same gooseberry bush were sprayed, one with a solution of ammonium sulphide containing 0·22 per cent. of sulphur, and the other with a 0·3 per cent. solution of liver-of-sulphur containing 0·13 per cent. of sulphur.* Other mildewed shoots on the same bush were reserved as "controls." When examined seven days afterwards, the mildew on the shoot sprayed with the ammonium sulphide was entirely barren and partly dried up and dead, while

* It is of interest to note that in both these solutions the sulphide sulphur content was the same.

the mildew on the shoot sprayed with the liver-of-sulphur solution was now densely "powdery" again—this spray, in fact, having had no more effect on the mildew than if pure water had been used. The mildew on the control shoots remained densely "powdery."

In neither of the above-recorded experiments was any scorching injury caused to the foliage or shoots of the gooseberry. In the field experiments carried out last summer by Mr. C. W. B. Wright at Midlothian, a solution of ammonium sulphide containing 0·15 per cent. of sulphur was used on 20 bushes of "Whinham's Industry." These bushes were sprayed fortnightly from the beginning of May until the middle of July, five sprayings in all being given to the same bushes. No injury was caused to the leaves or shoots; according to Mr. Wright's report "the solution appeared to induce a healthy foliage." The above experiment was duplicated on the same scale at Kinnaird, Perthshire, and gave the same results.

The only instance in which injury appeared to be caused by the ammonium sulphide solution was in one experiment in which a solution containing 0·26 per cent. of sulphur was sprayed on the leaves, berries and tips of shoots of a "Lancashire Lad" gooseberry bush growing in a pot in a greenhouse. On the 8th day the older leaves showed decided injury of a "scorching" nature, a slight leaf-fall had taken place, and two berries had fallen off. No further injury resulted.

The results obtained show that ammonium sulphide possesses properties which make it worthy of trial on an experimental scale by the commercial fruit-grower. A solution containing 0·18 per cent. of sulphur (0·1 per cent. of sulphide sulphur) should be used to commence with, and the concentration increased or decreased as circumstances demand.

Since, apparently, ammonium sulphide has not previously been used as a fungicide, its general action on the mildew may be noted here. The patches of mildew when sprayed remain white, and are but little altered in appearance to the superficial view, except that the *mycelium* may be more or less collapsed and flocculent in places; the *mycelium* remains persistently barren, and passes gradually into a dying condition. The fungicidal action is slow, and it may happen that as long as the 18th day after spraying the patches of mildew may still be white, although unable to recover.

Preparation and Dilution of the Ammonium Sulphide Solution.—*Stock Solution.*—One gal. of a 10 per cent. solution of ammonia in water is saturated at ordinary temperature with sulphuretted hydrogen gas, care being taken to avoid the use

of copper utensils and to prevent as far as possible the admission of air to the liquid during this operation. When the liquid is saturated 2 gal. of 10 per cent. ammonia solution are added and also 5 gal. of water. In this 8 gal. of liquor $1\frac{1}{4}$ lb. of flowers of sulphur are dissolved by agitation in a closed vessel. The addition of the sulphur changes the colour of the liquid from a pale yellow to a dark yellow clear solution, which constitutes the stock solution of ammonium sulphide.

When made according to the above directions, the specific gravity of the stock solution at 17°C. is 1, and it should contain 3·7 per cent. of sulphur, of which 2·2 per cent. should be in the condition known as "sulphide-sulphur." It is miscible with water in all proportions and generally exhibits properties similar to solutions of lime-sulphur and of liver-of-sulphur.

Dilution.—To prepare the diluted wash from the stock solution, 1 lb. of soft soap of a reliable brand is dissolved in 19 gal. of water, and into this quantity of soap solution 1 gal. of the stock solution of ammonium sulphide is mixed by stirring. In this manner 20 gal. of wash are prepared ready for use, containing 0·18 per cent. of sulphur and 0·5 per cent. of soft soap.

It will be noticed that the percentage of soap in the wash as recommended above is half that used in the writers' experiments, but they have reason to believe that in cases where soft water is used this amount of soap will be sufficient. Where the water is very hard, twice the amount of soap should be used.

It will be obvious from the above that the stock solution of ammonium sulphide is not one which can be prepared by the grower himself. Further, since this stock solution cannot in practice be tested by the grower, it should be purchased only from firms of repute who will vouch that it has been prepared according to the methods described above.

In view of the probability that a more concentrated and more potent stock solution can ultimately be prepared, further work on the subject is contemplated by the writers during the coming season. It is, however, not yet known whether in the preparation of stronger stock solutions than that described above the dissolved sulphur will be in the same chemical condition—*i.e.*, have the same fungicidal value—as when the above procedure is followed exactly. The fungicidal value of differently prepared stock solutions will have to be tested in carefully observed experiments before their use can be recommended to the grower.

Cost.—In view of the cheapness of the materials from which ammonium sulphide can be prepared and the simplicity of the operations involved from the manufacturer's point of view, the cost of manufacturing the stock solution should not be prohibitive.

Transport.—The means adopted for the proper transport of the stock solution and the precautions to be taken when handling it should be in every way identical with those adopted in the case of lime-sulphur.

Application.—In applying the ammonium sulphide and soft soap wash, a nozzle giving a fine "misty" spray should be used. The receptacle used in spraying must be wooden or iron (galvanised iron or tinned). A copper knapsack sprayer must not be used, because (as in the case of the lime-sulphur wash and liver-of-sulphur solutions) the dissolved sulphur acts on this metal.

All insecticidal substances which can be added to the lime-sulphur wash—such as arsenate of lead or nicotine—may, if required, be added to the ammonium sulphide solution.

Summary.—(1) Solutions of liver-of-sulphur of the strength generally recommended for use as a fungicide are quite inefficient against the American gooseberry-mildew; at a concentration at which the solution becomes fungicidal, such severe "scorching" injury is caused to the gooseberry bush as to preclude its use.

(2) An ammonium sulphide solution containing 0·18 per cent. of sulphur can be recommended for commercial use, *on an experimental scale*, for the purpose of protecting the fruit of gooseberries from mildew. In view of its proved efficacy, the lime-sulphur wash should be used for the early sprayings, until its use interferes with the marketing of the berries, when the ammonium sulphide solution should be used.

THE following notes have been prepared by Mr. J. C. F. Fryer, Entomologist to the Board, and Mr. G. P. Berry, General Inspector for Horticulture to the Board:—

Notes on Lime-Washes.

The insecticidal action of lime-wash when applied to fruit trees has always been a matter of controversy, and this is perhaps natural, for the washes in common use vary within wide limits, not only in their composition, but in the period and manner in which they are applied. The following notes deal only with certain aspects of the problem and are not intended as a discussion on the merits of lime washing in general.

Lime-washes in their simplest form are essentially "cover-washes"—that is to say, they imprison or impede the movements of insect pests which may be present on the sprayed trees. Frequently, however, their action is more complex owing to the addition of other substances which themselves may have some specific insecticidal action. There is then a difficulty in deciding whether good results are due to the mechanical action of the lime-wash or to the insecticidal powers of the substances added.

In this connection three cases of successful lime washing observed in 1915 are perhaps worthy of mention.

Case I.—A large orchard containing apples was lime-sprayed, while a second orchard, almost adjacent to the first and also containing apples, was left unsprayed. The sprayed orchard was treated with a wash containing 1 cwt. of quicklime to 60 gal. of water with the addition of a certain quantity of commercial lime-sulphur solution.

The work was carried out during April, and the later applications were made on trees on which the blossom buds had separated and were about to burst. So late was the spraying that some injury might reasonably have been expected, for the trusses in many cases were embedded in a cast of lime. No damage, however, was noted, and the orchard was remarkably free both from apple aphides and apple suckers which were present in abundance in the unsprayed orchard. There is some reason to suppose that the sprayed orchard would in any case have been somewhat cleaner than the unsprayed owing to work carried out the previous year, but the marked difference between the two cannot wholly be attributed to this, and it is believed that the lime washing was in the main responsible.

Case II.—An apple orchard was sprayed during March and April with a "self-boiled" lime-sulphur wash, the ingredients being in the proportions of 1 lb. sulphur, 5 lb. lime, 10 gal. of water.

The last section was not sprayed until the third week in April, when the blossom was in truss and about to open. This section was very free from apple aphides and apple suckers and produced the heaviest crop of apples. Further, it was noted that the foliage remained active unusually late in the autumn.

On the other hand the sections of the orchard which were first sprayed were severely attacked by apple aphides and lost their foliage, which was much injured, comparatively early in the autumn.

Case III.—A damson orchard was sprayed between 10th February and 7th March with a mixture of lime, water-glass and salt (lime 1 cwt., water-glass 5 lb., salt 20 lb., and water 100 gal.).

The orchard was treated in sections which may be indicated as A, B, C, D. On section A there was a severe aphis attack and little fruit was obtained. Sections B and C were less damaged, and the latter produced a fair crop. Section D was sprayed during the week ending 7th March, by which date the condition of the trees was so advanced that injury from the treatment was feared. No damage, however, could subsequently be traced, and section D remained free from aphis attack and produced a very heavy crop.

Discussion.—The above notes were made in commercial orchards which could not be kept under the close supervision possible in an experiment station, and they therefore lack many of the detailed observations which are usually desirable. At the same time in each case there were areas which acted as controls, and it seems permissible to draw certain conclusions.

In the first place, it would appear that an effective control as regards aphides was obtained whenever the trees were sprayed at a very late period—in fact, shortly before the blossom opened. Secondly, this late spraying caused no damage whatever to the foliage and blossom, though previously, from their advanced condition, some injury was anticipated. These conclusions apply equally to the apples and damsons, for the condition of the blossom at the dates of spraying was approximately the same in each case.

Finally, the sprays which produced these results differ materially in composition and need more detailed consideration. That used in Case I. contained a very high percentage of lime with the addition of boiled lime-sulphur solution—that is to say, a solution containing various chemical compounds of lime and sulphur, some of which are supposed to have a definite action on certain insects—notably, scale insects. In Case II. a "self-boiled" lime-sulphur was used. This wash differs from boiled lime-sulphur in that the entire heat required for its manufacture is produced by the lime when it is slaked and no fire is used to prolong the boiling. When made under ideal conditions it is believed that the sulphur is only reduced to a very fine state of division and that little of it enters into chemical combination with the lime. It differs radically, therefore, from boiled lime-sulphur, in which all the sulphur is combined with lime. In the formulæ given, however, there is a great excess of lime as compared with more usual formulæ for the preparation of this wash, and it is possible that a considerable proportion of the sulphur may have combined with lime. It would be unwise, therefore, to suggest the final constituents of the wash used, but it is evident that there must have been a great excess of free lime. The wash, however, was evidently "thinner" than those employed in Cases I and III.

In Case III., though the details are a little uncertain, it appears that a thick lime-wash was used with the addition of salt and water-glass. The action of the two latter substances is uncertain, but from some experiments it would appear that the salt may have some insecticidal properties. The water-glass, however, is only supposed to assist the lime in adhering to the trees, a contention with which all will not agree.

Comparing the three different washes which, in spite of their difference in composition, seem to have had much the same result; it appears evident that their insecticidal action must have been due primarily to their mechanical or "covering" properties. It would be unwise to speculate as to whether this action was exerted on the eggs of the aphides or on the newly-emerged insect, but in either case there seems no doubt that the more nearly the time of treatment approaches the hatching period of the insect the less important is the exact composition of the lime-wash and also the greater the chance of success.

The Cultivation of Buckwheat.

BUCKWHEAT is a native of the temperate parts of China, North West India and Central Asia, and is grown as a cultivated crop to a greater or less extent in most European countries in the temperate zone, and also in the United States and Canada. In Europe the crop is not so popular as it was, but large areas are still grown in Russia and France. The name "buckwheat" is probably a corruption of the Dutch "boekweit" or the German "buchweizen," or beech wheat, from the resemblance of the "seed" to the beechnut. Botanically buckwheat is not a cereal, but for agricultural purposes it is usually included among that class of crops.

In this country buckwheat is now grown only to a limited extent, chiefly on pieces of waste land to supply food for pheasants and other game, or on poor sandy soil as a green manure crop. This is mainly due to the fact that on land on which the ordinary farm crop can be satisfactorily grown the economic return from buckwheat is less than from the cereal crops. It is probable, however, that even in normal times the crop could be grown with advantage more extensively than it is, especially on the poorer soils and as a first crop in the reclamation of waste lands. At present buckwheat should commend itself for a number of reasons. It is sown very late in the season and can, therefore, take the place of crops which have failed or which have not been sown owing to pressure of work in other directions. At a time like the present, when any means of increasing the aggregate production of home-grown food is of importance, it is a point in its favour that the crop can be grown on land on which an ordinary cereal crop would yield indifferently or even prove a failure. The cultural preparation for the crop may, if necessary, be reduced to a minimum. It should be added that in common with the cereal grains the price of buckwheat has

increased and is now 40s. to 44s. per qr., as compared with 32s. to 35s. per qr. before the war.

Varieties.—There are three main varieties of buckwheat in cultivation, viz., the common type (*Polygonum Fagopyrum*, L.) Tartarian buckwheat (*P. Tartaricum*) and the Notch-seeded buckwheat (*P. emarginatum*). Of these the first-named variety is the only one in general use. Tartarian buckwheat is a smaller seeded variety and is considered better suited for poultry food, but is a somewhat shy cropper.

Description of Plant.—Buckwheat is an annual plant of erect habit of growth; under favourable conditions it may reach the height of 3 ft., although late-sown crops are usually somewhat shorter. The roots consist of a primary root with several branches and are, therefore, quite different from those of the true cereals. The stem is greenish or purplish red in colour, but changes to brown as the plant matures. Only one stem is produced from each seed, but the plant branches freely and thus adapts itself to the rate of seeding. The flowers are white, slightly tinged with pink.

Climate and Soil.—A moist, cool climate is best suited to buckwheat. The plant is very sensitive to low temperatures and is generally destroyed in a single night of frost; on the other hand the yield may be reduced by a continuous spell of dry weather during the later period of growth. The crop will thrive on a wide range of soils, but does best on a warm, well-drained, sandy loam. It will grow on dry sands and gravelly soils on which other crops would be very precarious, and will also often do well on peat land. Cold, wet lands, however, are not suited to it. Apart from the fact that buckwheat is hardly likely to compete with the usual cereal crops on the richer soils, there is a tendency for the crop to lodge badly, and as the plant is unable to recover, this is a serious matter.

Place in Rotation.—Buckwheat seldom occupies any special position in a rotation. It is usually sown on the poorest soil or as a substitute for a corn crop which has failed. It leaves the heavier soils in very mellow condition and therefore forms a good preparatory crop for roots.

Preparation of Land.—The cultural operations in the case of the buckwheat crop are usually reduced to the barest requirements, but it may be pointed out that more thorough preparation is well repaid. If possible the land should be ploughed early in the winter and subsequent operations should be directed towards obtaining a good tilth

Manures are rarely applied directly for buckwheat, the residues from applications given to previous crops usually being considered sufficient. Moderate applications of artificial manures, especially phosphates and potash, will, however, result in largely increased yields. On poor, sandy soils some farmyard manure should be applied if available.

Sowing the Seed.—The grain used for seed purposes should be of good weight and, if possible, selected from the previous season's crop. As the crop is exceedingly sensitive to frost the seed should not be sown until the end of May or beginning of June. When intended for a grain crop the quantity sown per acre should usually be about 1 bush., although up to 3 bush. may be required when broadcasting is resorted to. If drilled the distance between the rows should be from 12 to 15 in. As little moisture is needed for germination it is a mistake to bury the seed too deeply, $\frac{1}{2}$ to $\frac{3}{4}$ in. being sufficient. Provided the land has been well cleaned before sowing no further cultivation will be required until harvesting.

When intended for use as a green manure crop the seed should be sown broadcast up to the middle of July at the rate of 2 to $2\frac{1}{2}$ bush. per acre. It should be ploughed in when the plants commence to flower.

Harvesting.—If the conditions of growth have been favourable, the crop is usually ready for cutting in about 12 to 14 weeks from the date of sowing, *i.e.*, the end of August or the beginning of September. The selection of the correct time for cutting is an important matter, for the seeds ripen unevenly, and if the crop is left too long the earlier matured grain may be shed, while if it is cut too soon a proportion will be still unripe. Ripeness is indicated by the general browning of the crop, but even then flowers will still be noticeable on the lower branches.

The crop is probably best cut with a scythe or a mower, but, if desired, a self-binder may be used. In the latter case the sheaves are set up in shocks and usually threshed as soon as dry. Where the crop is mown it is turned several times as gently as possible for the first day or so; in many districts it is then placed in loose heaps through which the air can circulate freely. Proper harvesting of the crop may take from 10 to 14 days. When "made" it is frequently threshed at once; if it is desired to store it the stacks should be quite small. In threshing the smooth concave should be used in order to avoid cracking the grain and unnecessarily breaking the straw.

Yield.—The yield of grain varies widely, the average being

about 3 qr. per acre; on poor soils in bad seasons it may be less, while on richer land in a good year it may amount to as much as 6 qr. per acre. A bushel weighs about 50 lb.

Uses of Buckwheat.—*Bread, etc.*—In many parts of the Continent buckwheat bread still forms the staple diet of the poorer classes, while in the United States large quantities are used for human food in the form of buckwheat cakes, buckwheat groats, etc. The buckwheat is ground and the outer black hull separated. Properly ground buckwheat flour has a more or less dark tint due to the presence of fine particles of the outer envelope which are not removed with the hull. The grain must be well dried, and to secure the best results in milling the grinding should be performed in cool, dry weather. Under favourable conditions 100 lb. of grain will produce 60 lb. of flour, 24 lb. of middlings and 16 lb. of hulls.

Milling Process.—The milling process is described by Wiley in "Foods and their Adulteration" as follows:—

"During the process of milling the buckwheat grains pass to a receiving separator which removes all the coarse particles, stones, straws, etc., by means of a series of sieves. At the same time any dust which they contain is blown out by a current of air. The sifted grains pass next to the scouring machines, in which they are thoroughly scoured, cleaned and polished. From these machines the grain is passed to a separator containing magnets by means of which any pieces of metal, in the form of nails, screws, pieces of wire, etc., are removed.

"The grains next pass through a steam dryer for removing the greater portion of the water employed for the scouring. As soon as they are dry they are again treated to a blast of air, which removes any dirt, dust, or light particles which may have been detached during the process of drying. The grains next pass to the shelling rolls, where the greater part of the outer hulls is removed. This process is accomplished by means of an apparatus which is called a sieve scalper. After the separation of the outer hulls the residue of the material passes through a drying chamber, where the moisture is reduced to about 10 per cent., thus insuring the keeping qualities of the flour. After drying, the grains are ready for the rolls. After entering the rolls the process is practically the same as that which is employed in milling wheat, consisting of a series of breaks and reductions, with the attendant bolting and grading, and this process is prolonged until the flour is practically removed from the feed or middlings. The sifting cloths used in the bolting of buckwheat flour are somewhat coarser than

those for wheat, and this allows some of the dark particles of the inner hulls to pass into the flour, which gives it a dark colour on baking. It is quite possible to make a buckwheat flour as white as that from wheat, but in this country [America] the public taste requires a darker product, so that the white flour does not readily sell. The requisite degree of darkness is secured by using bolting cloths which will allow a part of the inner hull (middlings) to pass into the flour. Two grades of flour are generally produced—a whiter one in which finer cloths are used, and a darker flour made by using coarser bolting cloths, allowing larger quantities of middlings to pass through.

"The above process, while it makes a white and fine-looking flour, is not to be compared with the meal made in the old-fashioned way by grinding between stones and separating the principal part of the outer hull by bolting. This old-fashioned flour is more nutritious, that is, it contains more fat and protein, has a greater fuel value, or in other words has a greater number of calories and makes a much more palatable cake than the fine modern flour."

Use as a Feeding Stuff.—The buckwheat grain is characterised by a somewhat high fibre content, otherwise it is similar in composition to barley. The following analyses are chiefly from American sources :—

Analyses.

——	Water. %	Protein. %	Fibre. %	Carbo-hydrates. %	Fat. %	Ash. %
Grain	12·6	10·0	8·7	64·5	2·2	2·0
Straw	9·9	5·2	43·0	35·1	1·3	5·5
Grain (hulled) ..	13·0	13·1	2·2	67·2	2·5	1·9
Bran	12·8	10·6	30·7	38·9	3·0	4·0
Hulls	11·2	4·0	45·5	36·9	·8	1·7
Middlings ..	12·7	28·1	4·0	42·4	7·0	5·1
,, ..	13·0	20·6	2·8	55·4	5·2	3·0

Whole Grain.—The whole grain is of value as a poultry food, but the indigestible nature of the hull renders it an undesirable feeding stuff for general feeding purposes. The grain should only be fed in moderate quantities in a mixed ration.

Ground Buckwheat and Buckwheat Bran.—The composition of ground buckwheat varies within wide limits according to the proportion of hulls present. In small quantities in mixed rations ground buckwheat may be fed to most classes of live-

stock, but it is best suited as a fattening food for cattle and pigs; small quantities may also be fed to horses, but it is unsuited to young stock.

Buckwheat Middlings.—Buckwheat middlings form the most valuable buckwheat offal. They are practically free from hulls and may be fed to all classes of stock. Like ground buckwheat, however, they vary widely in composition. Many samples contain a high percentage of protein and fat and are much in demand as a food for dairy cows. The middlings may also be fed with skim milk for calf rearing.

In Belgium finely-ground buckwheat is extensively used for poultry fattening. In France also ground buckwheat and finely-ground barley meal are used for the same purpose. As a fattening food for ducks and geese a mixture consisting of three parts of buckwheat and one part of maize has been recommended.

Fodder Crop.—As a fodder crop buckwheat is best sown in a mixture with oats, mustard, etc. A good mixture is 40 lb. of buckwheat and 15 lb. of white mustard per acre. In Hungary a mixture of equal parts of buckwheat, field peas and vetches is recommended as a fodder crop for dairy cows.

The crop should be cut at about the time the buckwheat commences to bloom; in a fresh condition it contains on an average :—

	Per cent.
Dry matter	16·4
Protein	2·5
Crude fat	·6
Carbohydrates	7·6
Fibre	4·5
Ash	1·2

On account of its high moisture content the crop is most suitable for cattle, but it should not be fed in greater quantities than 50 lb. daily per 1,000 lb. live weight.

When it is possible to dry it adequately, buckwheat makes good hay. Usually, however, the drying process takes too long and it is preferable to make silage of the crop.

Buckwheat Straw.—Buckwheat straw is seldom used for feeding purposes, as its high fibre content renders it somewhat indigestible. On occasions, however, when other fodder is scarce, it may be fed to cattle and sheep with advantage. As litter the straw does not last well, but it makes good bedding for cows. As it is rich in mineral matter and rots quickly it also forms good manure.

Green Manure Crop.—As a green manure crop buckwheat has several advantages; it thrives on poor soil; it grows rapidly and smothers out weeds, thus helping to clean the land. It leaves hard soil in a mellow condition and decays quickly when ploughed in.

Disease due to Buckwheat.—When buckwheat products are fed in excessive quantities over long periods they may produce poisonous effects. The symptoms include congestion of the head, some delirium and, finally, considerable swelling of the head with eruptions on the skin. These symptoms will usually quickly disappear if the food is changed and the buckwheat portion eliminated.

References.—Handbuch des tierischen Ernährung, Pott.
Cornell, Bulletin No. 238.
" Cereal Crops," Hunt.

The Growing of Mustard Seed.

THE question of growing mustard for seed is worthy of consideration at the present time. Two species of mustard are met with in cultivation—the *white mustard*, with yellow seeds, and the *brown* or *black mustard*, with brown or dark-coloured seeds. The former is best known as a catch-crop for sheep feed or for ploughing in as green manure, and for the production of seedlings for salad. The crop, however, is also grown extensively in some districts for its seeds, which are used in the manufacture of mustard for domestic purposes. The latter, or brown species, is cultivated solely for its seeds. These are ground, and the flour, after admixture with a proportion of the milder and less pungent flour of the white mustard, is used for making the well-known condiment.

At the present time brown mustard is quoted on the London Market at £7 16*s.* to £7 18*s.* per qr. (448 lb.), and white mustard at 10*s.* per qr. less. These prices, which are much above the average for the past few years, are attributable to a number of causes, including a lessened home production due to unfavourable weather during the early stages of the growth of the crop, the stoppage of imports from the Baltic ports, and an increased demand from America. In normal times the market for home-grown mustard is strictly limited, and any considerable extension of the area under this crop would be attended with some risk, but so long as the present conditions continue there is likely to be a good market at home with the probable continuance of a demand from abroad.

It would be well, however, to confine the growing of brown mustard for seed to those areas that have proved best adapted for the purpose in the past, viz., the good fenlands and marsh-lands of Lincolnshire, Cambridgeshire, Huntingdonshire, and Norfolk, as this crop requires a deep, moist, well-drained fertile soil, free from acidity. There is one serious drawback to the cultivation of brown mustard. The seed, especially if the crop is over-ripe, is apt to shell out at harvest and cause trouble in subsequent crops.

White Mustard.—This article deals mainly with the conditions best suited to *white* mustard, as it is adapted to a much wider range of conditions than brown mustard, both as regards soils and weather, and causes less trouble from shed seed. It can be grown more or less successfully on all kinds of land, and is a safe crop to take on freshly-ploughed grass-land as wire-worms attack it only slightly or not at all. On heavy, clay lands, it is often taken after dead fallows, the following crop being wheat. This system invariably proves a great success, both as regards the mustard and the wheat. On heath and light lands, white mustard is taken before barley. It is said that where turnips will grow white mustard will succeed.

Seed Bed.—The ground requires thorough preparation, and a fine and fairly solid seed bed is essential.

Manuring.—If the land is in good heart the only manure needed is 3 to 4 cwt. of superphosphate per acre. In other circumstances a good dressing of farmyard manure, say 10 to 15 tons per acre, should be given, in addition to the superphosphate.

Seeding.—White mustard may be drilled at any time from the first week in April to the middle of May. If it is sown earlier it runs the risk of being cut off by frost, but if the earlier sown crop is successful it has the advantage of coming to harvest before the corn harvest begins. The seed should not be buried more than half an inch, or it will not germinate evenly; it is usually drilled on the flat in rows 12 to 18 in. apart. Some growers drill 12 in. and chop out the plants 9 in. in the rows or, to save labour, run the horse-hoe across the crop; on good land the plants require more room to enable them to branch. If the seed-bed is sufficiently fine, half a peck of seed, or slightly less, will be ample for 1 acre.

Harvesting.—Great care should be exercised in judging the correct time to cut: if cut too early the seed will be green and shrivelled, while if it gets too ripe there is great loss through seed shelling on the land, especially in windy weather. Old growers say they wait until the colour of the pods assumes the

brownish tint of a hare's back. It is advisable to cut the crop slightly on the green side and give it plenty of "field room" to enable the plant to dry out thoroughly. White mustard is generally cut by hand with sickles, and laid on the ground in small bunches; but when there is a scarcity of labour or the men are not used to this form of cutting, the ordinary corn binder does the work well. Small sheaves should be made and not tied too tightly, and the crop should be cut as high as possible so that the high stubble may form a good resting place for the sheaves. The sheaves should be turned after two or three days, and carted when thoroughly dry. In carting, care must be taken to prevent loss of seed; cloths should be put over the racks or frames fixed to the carts to catch the shed seed, and this should be distributed over the stack from time to time and not laid in heaps, or the seed will turn mouldy.

Stacking.—A good "staadle" is necessary. This may consist of faggots or brushwood covered with straw or coarse grass on top of which should be placed a cloth or old bags to catch the shelled seed. The stacks should be relatively small, about four yards wide, to prevent over-heating. In some districts, stacking is obviated by threshing the crop in the field.

Threshing.—This is done with the usual tackle, the only extra parts required being four sieves of smaller size than those in normal use; such sieves can usually be supplied by the makers of the threshing machines.

Yield.—The yield varies very greatly. It may be as much as 40 bush., but is normally about 16 to 20 bush., or a little more, per acre.

The chaff (pods) is used for feeding; the straw is practically of no value for fodder, but may be used for the bottoms of stacks and cattle yards, and it is used in some parts to form shelter walls around open cattle sheds.

Seed Potatoes.

IN the warmer southern and south-eastern districts of England it has long been recognised by the principal growers that a change of "seed" from Scotland or from Ireland is desirable *every* year. In the cooler parts of England a change every second or third year is considered sufficient. It is well established that climatic and soil conditions do exert an important influence on the vitality of seed tubers. It is held by some authorities that a moist, somewhat acid soil provides the best change. Where it is impossible this year, in view of transport difficulties, to obtain the desired change, growers, in using home-

grown seed, should be careful to plant only those tubers showing vigorous signs of life. It is desirable, therefore, that all seed tubers should be sprouted before planting, either by "boxing" or by spreading in a thin layer on a suitable floor, and, in the absence of northern-grown "seed," cut "ware" tubers, direct from the north or obtained from once-grown northern stock, should be used in preference to whole "seed" grown locally. Further particulars on the subject will be found in the Board's leaflet No. 173 (*Potato Growing*).

In connection with the subject of "seed" potatoes the following notes on experiments made in America on the mulching of crops grown for "seed" will be of interest.*

Potato growers in the United States, as in this country, have long recognised the necessity of obtaining, from time to time, a new stock of seed, preferably from a northern district, in order to overcome the gradual deterioration which occurs if home-grown seed is continuously employed. The superiority of northern-grown seed is believed to be primarily due to the cooler soil, which enables the tubers to mature more slowly and equably than would be possible in a warmer district. It was thought possible that the application of a mulch of straw or similar material to seed potatoes in their native districts might afford low and fairly uniform soil temperatures similar to those which assist the complete development of northern-grown seed. Tests were, therefore, carried out from 1904 to 1912 at the Nebraska Agricultural Experiment Station to determine the value for seed purposes of mulched home-grown tubers in comparison with northern-grown tubers and with those grown at home by ordinary cultivation methods.

In testing the relative merits of the two sorts of home-grown potatoes, care was taken that the mulched and unmulched seed should receive identical treatment as regards storage and subsequent planting. The superiority of the mulched seed over that raised by ordinary cultivation was very marked throughout the test. For each 100 lb. of produce obtained from mulched seed the yield from unmulched seed ranged from 77 lb. after one year's test of each down to 54 lb. after 8 years' continuous reproduction. It was found, moreover, that even one year of ordinary cultivation greatly reduced the strength of a stock previously mulched. Thus, a stock which had been mulched for 8 years yielded 60 per cent. more than part of the same stock unmulched for one year after having been mulched for 7 years.

Comparisons of home-grown mulched stocks with stocks

* University of Nebraska, Agric. Expt. Station, Bull. No. 146.

imported from a northern district showed that, on the average, for each 100 lb. produced by the former the latter yielded 98 lb.

The extra cost entailed in producing seed tubers by mulching with straw instead of by cultivating between the rows was estimated at about £2 2*s.* to £2 10*s.* per acre. At this rate the extra cost would not be more than about 5*d.* or 6*d.* per bush., and if mulching increases the yield by as much as from 20 to 25 per cent., as may ordinarily be expected, the cost per bushel should not differ greatly for the two methods. In the Nebraska district the price of northern-grown seed at planting time is from 20 to 30 per cent. higher than that of home-grown cultivated tubers, representing a difference of, perhaps, 10*d.* to 1*s.* per bush. It is claimed, therefore, that a grower can produce high-class seed potatoes at home by mulching at a cost somewhat less than he can buy northern-grown seed of equal quality. This point appears to be worthy of consideration in this country.

The bulletin recommends that a few rows of potatoes should be mulched along one side of the field to furnish seed for the next year's crop. The mulch may consist of hay, straw, stable litter, or other coarse material free from grain and noxious weed seeds, and should be about 4 in. deep after settling. A deeper mulch adds greatly to the cost and may impair the growth of the plants. The mulch is best applied before the plants come up, and must in any case be spread by the time the new tubers begin to develop. To ensure that the plants are strong enough to grow through the mulch, and to produce as high a yield as possible for a given amount of mulching, large pieces of seed (from 4 to 6 oz.) should be planted at a depth of about 4 in. It is stated that the only conditions under which mulches, properly applied, are likely to reduce the yield are excessively wet weather or soil that is not well drained.

It should be emphasised that the estimates of cost are based on the assumption that a supply of suitable mulching material is available on the farm, no allowance being made for the value of the material used. If the mulch has to be purchased it is extremely doubtful whether the process would ever be practicable on the farm, since these experiments appeared to show that from 17 to 20 tons of straw or other litter may be needed to mulch 1 acre of potatoes to a depth of 4 in.

Where, however, sufficient litter is available mulching might prove useful in growing "seed" of new and expensive varieties, and in raising small stocks of seed: a small patch intended for seed might be dressed with artificials in the rows, and the ordinary dressing of stable manure might be applied as a mulch between the rows.

The Rearing of Chickens.*

SUCCESSFUL poultry-keeping depends largely upon the methods adopted in rearing chickens, and at the present time when there is so much need for improvement and for an increase in the stock of poultry, it is important that all those who rear chickens should adopt methods which will produce healthy and vigorous stock and will at the same time secure economy in feeding and labour.

In this article attention is drawn to two typical systems of rearing which have been found successful in practice. It is not necessary that they should be rigidly adhered to, but they are tested methods which will guide those who have adopted no definite system in the past.†

There are two recognised systems of chicken feeding, viz., the wet mash system and the dry feeding system, and each has its advantages. Of late years, however, the latter has become increasingly popular, as it effects a great saving of labour; the grain mixture may be scattered among the litter in sufficient quantity to last all day, while the chickens derive great benefit from the exercise entailed in scratching for the food. On the other hand, wet mash feeding is usually favoured when table poultry are required. For general purposes a judicious combination of the two systems will probably produce the best results.

SYSTEM I.

First Week.—During the first week of their existence the main requirements of the chickens are adequate heat and protection, and the development of their sense of direction and power to forage for food.

Methods Suggested.—From the time the first egg begins to chip in the incubator the machine should be closed and not opened again for 24 hours. During this time a steady temperature of 104° F. should be maintained. At the end of 24 hours the chickens should be removed to their brooder in a basket that is well lined with soft, dry grass, hay, or two layers of an old blanket. They should be covered up directly they are placed in the basket, as any exposure causes them to lose some of their body heat. Crippled or weakly chickens can rarely be reared profitably and should be destroyed at once as humanely as possible.

* Reprint of Special Leaflet No. 54, just issued, copies of which will not be sent to subscribers to the *Journal* without special application.

† Further suggestions for the feeding of chickens are given in Leaflet No. 114 (*Feeding of Poultry*).

To ensure the best results, no more than 50 chickens should be raised in one flock—at all events during the early stages of rearing. Overcrowding, whether it be in a brooder, coop or house, is a fatal mistake.

Preparation of the Coop or Brooder.—Any suitable form of coop may be used. One of the most inexpensive and convenient forms is the calico coop, which has already been fully described and illustrated in this *Journal*, January, 1916, p. 975.

This coop has a floor space of 6 ft. by 6 ft. and a substantial frame or skirting which surrounds its floor and encloses and supports the litter bed.

The Litter Bed.—This may consist of short, dry, lawn clippings or soft meadow hay cut up as finely as the chaff cutter will allow Short cut clover or lucerne is also an excellent litter for chickens. The chickens will consume large quantities of this litter, and it should therefore be regarded as forming a considerable proportion of their bulky food. This being so the litter should be changed directly it becomes tainted. A deep litter bed will often suffice for two flocks of chickens without becoming tainted, but its life will depend upon the dryness of the land, the weather, and the care expended in adjusting the roof of the coop so as to exclude driving rain. Any portion of the bed which may become wet should be at once changed.

The best position upon which to raise chickens is a fine grass turf in which there is a good admixture of White Dutch Clover. The ground should, if possible, be dry and level, and the grass kept short.

The coop should be placed upon a couple of cross supports so that its floor just clears the ground. Each of the four sides of the coop in the illustration has a small trap door, opening directly across the upper edge of the floor frame or skirting, and fitted with a short ladder board to allow the chickens to enter and leave the house (p. 1141).

The litter bed should be made level with the top edge of the door frame—a depth of 9 in.—and the dry food should be evenly distributed throughout the litter. If this has been satisfactorily done a grain or two of chick food can be found within every square inch or so of the litter.

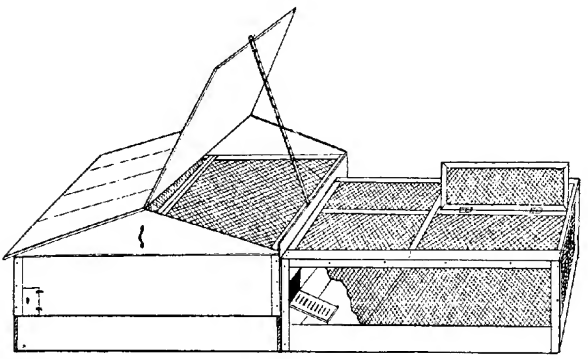
After the dry chick food has been added and the surface made level, the birds should not be interfered with again until they have removed most of the dry grain.

Feeding.—The following chick feed, mixed thoroughly in equal parts by measure, has been found to give good results:—

1. Finely kibbled wheat.
2. ,, ,, maize.
3. Rolled breakfast oats or coarse oatmeal.

The smaller the particles of grain the longer the chickens must work for its recovery. In passing the grain through the kibbling machine a certain proportion of flour is produced. This fine material should be sifted out of the mixture, and used in the dry mash, as it would not be recoverable from the litter. The wheat and oat flakes of this mixture will retain their positions in the litter far more evenly than small seeds and grains.

Provision of Artificial Heat.—A portable hover should be prepared and placed upon a square board which rests upon the surface of the deep litter bed in one corner of the coop. The



board should be just large enough to form a floor for the hover. Upon it should be placed a bed of long wheat straw of sufficient depth to keep the chicks from coming into contact with the board at any point. This long straw, if properly laid down, with the blades arranged more or less in a circle, will act as a filter for the droppings which dry and fall through the straw on to the surface of the wood. The droppings can be removed every day or every second day according to circumstances. Straw so placed remains in position and cannot be scratched away by the chickens.

It is of great importance to regulate the temperature so that it meets the requirements of the chickens; extremes of temperature should be carefully avoided. A thermometer cannot be regarded as a sufficient guide in itself, and it is better to observe closely the action of the chickens themselves. If the hover is too cold, the birds will crowd towards the lamp, a practice which is very detrimental to their health. It is a habit easily acquired and, if once learnt, only eradicated with difficulty. If, on the other hand, there is too much heat, the chickens will pant, become restless, and separate from each other in their desire to secure a cooler environment. The conditions may be considered suit-

able when the chicks are sleeping quietly, more or less apart, and resting on the straw.

As the temperature of the hover rises when chickens are placed beneath it, owing to the addition of their body heat to the heat of the lamp, it is best not to make any alteration in the latter for about one hour after the chickens have been moved from the incubator. As a rough guide the thermometer should then read 90°F. From day to day this heat will tend to rise owing to the flock increasing in weight and heat-producing power; the instructions issued with the machine should therefore be followed and the condition of the birds should be carefully watched. As a general rule it may be stated that artificial heat should be gradually reduced until, at the end of about 4 weeks, the chickens no longer require it.

When the chickens have been safely transferred from the incubator to the brooder their movements should be very restricted for the first forty-eight hours. To effect this, a strip of matchboard enclosing a small triangular space of litter bed is placed outside the hover. In this space a suitable chick water fount should be placed, and also a shallow hopper containing dry mash.

The dry mash at this stage may consist of equal parts of dry wheat bran and rolled breakfast oats and should be kept continuously before the birds. If the chickens are placed once or twice within the hover, they will readily learn to go in and out seeking the mash when they require it. The exercising ground can then be extended by degrees until the whole bed is available for scratching.

After three days rolled oats should be omitted from the dry mash, for the purpose of economy, but bran should be kept constantly before the chickens. Finely divided, fresh, and tender green food, such as lettuce or dandelion, should also be constantly available so that they may soon learn to eat it.

A supply of chicken grit should be placed in a small box, and a sanitary water supply at all times is absolutely necessary. To guard against disease a few crystals of potassium permanganate should be added to the water. Once the solution in the water fount loses its characteristic light claret shade it should be changed without delay. An inverted water bottle fount is an excellent appliance for very young chickens.

Second Week to Fourth Week.—From the second to the fourth weeks the chief requirements of the chickens are suitable food, plenty of open air exercise, heat to a decreasing extent, and protection.

Methods Suggested.—If the weather is at all suitable, the chicks should have daily access to a limited area of good grass turf. It is waste of time and labour to place them on turf largely composed of coarse grass tufts.

To provide frequent changes to fresh turf, without moving the coop for some time, it is an advantage to have a trap door in each of the four sides. A wooden frame should be constructed as shown in the illustration. It should have a floor space 6 ft. by 6 ft., and should be sufficiently high to cover the trap doors. The top and sides of this cage should be covered with 1 in. mesh wire netting in order to exclude sparrows and other vermin.

A tarpaulin made of unbleached calico (cheap grade), proofed with two coats of hot boiled linseed oil to which a proportion of gelatine has been added, may be placed in position to cover the roof of the cage but not its sides. A few eyelets and light lashings are also necessary. The semi-transparent cover should be kept in position during showery or uncertain weather and removed when the weather is fine. The chickens should always be confined to the coop itself towards nightfall.

The cage can be moved to any given plot round the coop itself, until all four plots are soiled when it is time to move the house to fresh ground. It is an advantage to place the dry bran hopper and water fount within the cage.

Feeding.—The following foods are suggested:—

(*a*) The dry chick food of the litter bed.

(*b*) A constant supply of dry wheat bran.

(*c*) Grit, green food, and fresh water.

In addition to this, from the second week onwards, the birds should receive a small quantity of animal food, such as beef scrap, fish meal, milk or butter milk (always sour or always fresh), or bullock's liver. The chickens should be given all they can eat up very quickly once a day—say at 12 noon. A good method of feeding milk is to cut several slices of stale bread, soak them in milk and feed them whole.

Fifth Week to Seventh Week.—About the end of the fourth week, if the weather is favourable, the chickens may be transferred from the heated brooder to fireless brooders.

About the sixth week dry mash is substituted for the bran. It should be very thoroughly and evenly mixed, and may be prepared as follows:—

Stock Mash (by weight).—

Maize meal	27 lb.	Linseed meal ..	3 lb.
Sussex ground oats ..	30 ,,	First quality fish meal	10 ,,
Middlings	30 ,,		

Dry Mash as Fed (by measure).—

Stock mash .. .. 1 part. | Dry wheat bran .. 4 parts.

This may be kept always before the birds up to the eighth week, discarding the milk or meat formerly fed at noon.

At this stage the young stock should have access to larger grass runs. Indeed, this step may with advantage be taken from the fifth week onwards provided the weather conditions are favourable.

Eighth Week.—About this time the birds are not so energetic in working in the litter, and otherwise show a tendency to become inactive, even when at liberty. They are inclined to grow "lean and lanky rather than fat" and their crops, if examined when night falls, will not be nearly so well packed as usual.

The deep litter feeding and the continuous application of dry mash should cease and whole wheat or finely cracked maize, or a mixture of both, should be provided at the rate of one good handful per bird per day.

The grain should be measured out as suggested above and divided into two equal parts, one of which should be fed first thing in the morning and the second about 11 a.m.

The grain should be evenly distributed over and well raked into the litter bed. The birds should also be provided with *all* the tender green food they will consume without waste during the morning hours.

At 1 p.m. a very small amount of moist mash or bread and milk should be fed. The stock mash mixture, to which four parts by measure of steamed bran and a moderate amount of milk or butter milk have been added, will be just what the birds require. They should be allowed four to five minutes' access to the food which should then be removed.

At 2.30 p.m. the dry mash hoppers should be opened and the birds allowed to have all they can consume before night. In order to ascertain whether the feeding is likely to carry them safely and evenly towards maturity, a proportion of them should be examined every night after they have gone to roost. Should examination of the crops of the birds prove that they are only partially filled, less moist mash should be fed at 1 p.m., or the dry mash should be still further reduced by opening the hoppers at a later hour. It is most important to ensure full crops at nightfall.

Treatment of Cockerels.—It is very important to separate the sexes at an early date. Once the cockerels reach maturity one handful of good grain per day fed in the litter for each bird, with plenty of green stuff, and access to free range for several hours

each day will keep them in prime condition. The birds may also have access to the dry mash hoppers for one hour just before nightfall. Over-feeding is especially injurious to mature cockerels.

The Use of a Free Range for Young Stock.—A flock of chickens will not roam continuously over any range for a complete day.

A little observation will indicate the number of hours each flock takes full advantage of the open run; and when this period has elapsed the birds should be returned to their deep litter and cage enclosure and the range should be devoted to another brood. Under such a system of management a given area of grass land will carry a much larger number of chickens.

SYSTEM II.

The following system of feeding and management is that employed in the Chicken Rearing Demonstration at Morden Hall, where the birds were intended for table purposes.

Rearing (Total period 12-16 weeks).

The chickens are left in the incubator until the twenty-second day, when they are transferred to the brooders. For the first two weeks, they remain in a portion of the rearing ground where they can be kept under constant observation. The brooders used at Morden Hall were each capable of accommodating 60 chickens up to the age of from 5 to 7 weeks.

Each brooder is placed in a run enclosed by wire netting 2 ft. high, supported by light stakes placed at intervals. These runs may conveniently measure 9 yds. by 40 yds., and are used for the chickens up to the age of seven weeks.

Each Sussex ark is placed in a run measuring 40 yds. by 20 yds., enclosed by wire netting 4 ft. high supported by stakes. Access is gained to the larger runs by an arrangement which permits of a short length of the wire netting between two posts being swung aside. When seven weeks old the chickens are transferred to these arks in lots of 40.

First Week.—During the first week the birds are provided at frequent intervals with as much food as they will clear up. The food consists of the following mixture (by weight):—

Wheat (cracked)	50 per cent.	Best meat meal	10 per cent.
Millet	15 ,,	Maize (cracked)	5 ,,
Canary seed ..	15 ,,	Rice	5 ,,

An unlimited supply of pure water is always provided, and grit is scattered on the floor of the brooder, and is constantly available throughout the whole process of rearing.

Second Week.—During the second week the birds are fed in the following way:—

At daybreak	Chick feed
At 9 a.m.	Hard boiled egg.*
At 12.30 p.m.	Chick feed.
At 6 p.m. (or half-an-hour before sunset, according to the season)	Chick feed.

When the chickens are two weeks old they are moved to a brooder in the centre of the rearing field, and are confined for one day in a small wire run attached to the end of the brooder. This small run is then removed, and the chickens have access to the larger run in which the brooder is placed.

Third and Fourth Weeks.—Three tins containing chick feed, and fitted with wire guards to prevent the birds scratching out the food, are placed overnight in the brooder so that the first feed may be obtained at daybreak. These tins are removed when the birds are let out of the brooder, and a tin of groats is provided for them. At 9 a.m. soft food is given, consisting of biscuit meal with 10 per cent. of meat meal. The biscuit meal and meat meal are mixed with boiling water and dried off with equal parts of sifted barley meal and sharps. The mixture when prepared should be crumbly, the utmost care being taken to mix the ingredients thoroughly and avoid the use of "sloppy" food, which is a frequent cause of trouble. At the same time any groats which have not been cleared up are removed. At 1 p.m. soft food prepared as described above is given to the chickens. About 6 p.m., or earlier according to the season, the birds receive as much dry chick feed as they will eat.

Fifth, Sixth and Seventh Weeks.—At the beginning of the fifth week after hatching, and until they are seven weeks old, the chickens are fed as in the fourth week, but instead of the chick feed they receive a mixture consisting of 60 per cent. whole wheat and 40 per cent. chick feed.

When the chicks are seven weeks old they are moved to larger runs and are housed in Sussex arks, which are provided with slatted floors through which the manure falls. Wooden floors are placed on the ground below the arks in order that the manure may be collected and used.

Eighth to Sixteenth Week.—At 7 a.m. the birds receive a mixture composed of 1 lb. meat meal, 2 lb. biscuit meal and 1½ lb. bran. This amount is soaked in 1¼ gal. of boiling water and dried off with a mixture composed of 2 lb. barley meal and 9 lb. fine sharps.

* In view of present conditions, bread and milk prepared as described above may be substituted.

This ration is given to the birds again at 1 p.m. The evening feed consists of 90 per cent. of whole wheat and 10 per cent. of cracked maize.

An alternative system of feeding which has proved advantageous is as follows:—

7.0 a.m.	..	Soft food (as described above)
10.30 a.m.	..	A half feed of mixed grain.
1.30 p.m.	..	A half feed of the soft food.
6.0 p.m.	..	As much mixed grain as the birds will eat.

Precautions for the Safety of Day-Old Chickens Received by Post or Rail.

1. Preparations should be made for the chickens before they are due to arrive. On arrival they must be kept warm, either by securing a quiet hen who will brood them, or by means either of an artificial rearer, or of the temporary substitute described below.

2. If it is decided to rear the chickens by natural means, select beforchand one, or if possible, two quiet hens which are thoroughly broody. Dust the birds with a reliable insect powder once or twice to free them from parasites. Prepare suitable nests* for them, set them on nest eggs and provide them regularly each morning with grain and water. Give two or three chickens to the hen *after dark* and carefully observe how she behaves. If she appears restless, jerks her head rapidly towards the nest at intervals and does not "croon" to the chickens, she should be rejected and another hen should be tried. If she croons to the chicks and appears quiet and settled, she is likely to prove satisfactory and 10 or 12 chicks may be entrusted to her.

3. If the chickens arrive in the daytime they must be kept warm until they can be given to the hen. Chickens do not require food for at least 48 hours after they are hatched, but they must have warmth.

4. *Artificial Brooders* are of various types but they all require reasonable care and intelligent management. The lamp of the brooder—if a lamp is used—must be refilled and the wick must be trimmed regularly. Good paraffin oil should be used, and no oil should be allowed to remain on the outside of the reservoir. Whatever type of brooder is selected for use, examine it thoroughly, and remove and replace the various parts so as to become familiar with the structure of the machine. Test the brooder thoroughly before the chickens arrive and work it in accordance with the maker's directions.

* *See* Leaflet No. 305.

5. *Other Means of Providing Heat.*—Procure a basket that will serve as a warm nest when filled with fine dry hay or grass; and, if possible, line it with a handful of downy feathers. The nest should be *just sufficiently large to hold the chickens.* Cover the top of the basket with a full-sized piece of flannel or blanket, gently pressed downwards into the hollow of the nest until it just touches the back of every chicken. Place a layer or two of soft paper into this hollow. If the weather or room be cold, place several layers of flannel and paper over the chicks. However you arrange matters place the basket with the chickens near a fire, or other steady source of heat. Then leave the birds for one hour, after which you should gently raise the nest cover to ascertain what the conditions are. If the birds are spread out, breathing quietly and show dry fluffy coats, all is well. Cover them as before. But if they are spread out, panting, with coats discoloured with streaks of moisture (appearing as if shrunken in size) the nest is too warm and the covering should be reduced. The larger the flock the less the cover necessary to produce proper and safe conditions in the nest. This improvised fireless brooder should only be adopted as a temporary measure until sitting hens that *will* accept the chickens are obtained.

6. Particulars of suitable methods of feeding will be found in Leaflet No. 114.

Safe Disposal of Hatching Eggs Received by Post or Rail.

1. Open the lid of the box with care; remove it gently; nails or tacks should never be used for securing the lid of the box.

2. Hatching eggs should not be enclosed in slips of paper twisted at the ends. The sudden twisting of the paper may injure the germ. Unpack each egg carefully.

3. Every egg should be spotlessly clean. If soiled, or coated with albumin as the result of breakages in transit, wash the shells with warm water, soap and washing soda, after which rinse them in clean cool water.

4. Then place the eggs in a cool place to rest for 24 hours before putting them under the hen or into an incubator.

5. If an incubator be used, run it steadily for 24 hours in accordance with the maker's directions before placing the eggs in it. The cold eggs will cause the temperature to fall. Do not interfere with the regulator for 24 hours after the machine is finally closed, but maintain the lamp flame exactly at its previous level. In using a machine for the first time, or when working a new machine, read the maker's directions carefully and follow them in detail.

6. If hens are used they should be quiet, *in good condition*, should be dusted with a reliable insect powder to free them from vermin, and should be tested on china eggs for 24 hours or more before the hatching eggs are placed beneath them.*

7. A quiet hen will take the eggs at any time, as one by one they are gently slipped beneath her, *but it is preferable always to set a hen at night.*

8. The number of eggs to place under a hen depends upon her size and the season of the year. An average hen will hatch 10 eggs more efficiently than 13 at any time; and it is safe practice to divide a valuable sitting between two, or even three, broody hens if they are available.†

9. Eggs, whether placed under hens or in an incubator, should be tested on the seventh day. In the case of eggs received under the Board's Egg Distribution Scheme, *infertile* eggs alone will be replaced provided that they bear the official stamp, and are returned to the Station Holder carriage paid.

Notes on Feeding Stuffs in February: *From the Animal Nutrition Institute, Cambridge University.*

THE chief feature of this month's prices, besides the general all-round increase, is the great variation in price between the different markets. The price of maize meal, for instance, is £14 per ton in London and only £12 7*s*. 6*d*. in Liverpool. This is not the only case. Differences of £1 per ton between markets are quite general. The cause, no doubt, is the increasing difficulty of railway transport. With such differences between markets, it is misleading to average the prices per food unit, so a separate list is given of prices per food unit at each market. To avoid repetition the prices per food unit have been removed from the large table.

Table I., therefore, gives the number of food units per ton and the prices per ton at the four great markets. Tables II., III., IV. and V. give in order the prices per food unit on the London, Liverpool, Hull, and Bristol markets, respectively. Table VI. gives the average prices per food unit at all the four markets. Table VII. gives particulars of composition and feeding value, as in former notes.

The writers have to thank Professor Crowther, of Leeds University, for sending them figures which have enabled them

* *See also* Leaflet No. 305. † Particulars of suitable methods of feeding will be found in Leaflet No. 114.

to revise their estimate of the composition and feeding value of palm-nut kernel cake. Other correspondents also deserve thanks for useful information on several points.

TABLE I.

Feeding Stuff.	Digestible Food Units.	Approximate prices per ton at the end of January.								
		London.			Liverpool.			Hull.			Bristol.		
		£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Soya Bean Cake	122·3		—		12	5	0	11	10	0		—	
Decorticated Cotton Cake	126·3	12	13	9	13	2	6		—			—	
Indian Linseed Cake ..	123·1	13	6	3	13	0	0		—			—	
English Linseed Cake ..	120·1	13	13	9	13	15	0	13	2	6	13	12	6
Bombay Cotton Cake ..	65·3	10	7	6	10	10	0	10	0	0		—	
Egyptian Cotton Cake ..	71·9	10	10	0	11	0	0	10	10	0	10	12	6
Coconut Cake	102·6	10	17	6	10	15	0		—			—	
Palm-nut Kernel Cake ..	90·5		—		9	10	0		—		9	2	6
Ground-nut Cake	145·2	*12	0	0	10	15	0	12	5	0	12	10	0
English Beans (new) ..	99·5	11	13	8	13	10	8	12	4	3	12	0	0
,, ,, (old) ..		12	12	8									
Chinese Beans	101·2	11	18	0		—			—			—	
English Maple Peas ..	97·2	14	13	4		—		14	17	9		—	
English Dun Peas ..	97·2	13	0	0		—		12	4	5		—	
Calcutta White Peas ..	97·5	17	2	3		—		17	15	7		—	
American Maize	93·8	13	1	4	12	0	10		—			—	
Argentine Maize	94·2	12	5	0	11	13	4	11	12	2	12	1	6
Maize Meal	86·5	14	10	0	12	7	6	13	2	6	12	12	6
Maize Gluten Feed ..	121·6	12	0	0		—			—		12	7	6
Maize Germ Meal ..	99·2	13	0	0	12	10	0		—		12	12	6
English Feeding Barley ..	83·0	14	0	0		—		14	11	2		—	
English Oats	75·4	12	0	0	12	8	11	12	0	0	11	13	4
Argentine Oats	75·4	12	10	6	11	16	5		—		12	3	2
Malt Culms	69·9	6	15	0	9	0	0	7	0	0	8	10	0
Brewers' Grains (dried) ..	84·5	†8	15	0		—		8	15	0	9	12	6
,, ,, (wet) ..	21·1	§1	7	0		—		1	10	0		—	
Egyptian Rice Meal ..	78·7		—			—		10	0	0	9	15	0
Burmese Rice Meal ..	78·7		—		10	5	0		—			—	
Wheat Middlings	93·4	10	5	0		—		10	5	0	11	15	0
Wheat Sharps	86·3	10	0	0	11	15	0	10	15	0	10	17	6
Wheat Pollards	81·9		—		10	5	0		—			—	
Wheat Bran	77·5	9	10	0	10	5	0	9	15	0	9	7	6
Wheat Bran (broad) ..	79·9	10	0	0	11	0	0	10	5	0	9	17	6
Feeding Treacle	60·0	9	18	9	10	12	6		—			—	
Linseed	153·5	20	11	11	26	0	0	22	17	8	20	17	4
,, Oil	250·0	‡44	0	0	‡48	0	0	41	15	0	49	15	7
Egyptian Cotton Seed ..	108·6	14	0	0		—		15	12	6		—	
Brazilian ,, ,, ..	107·6		—			—			—			—	
Cotton Seed Oil	250·0		—		‡55	0	0		—			—	

* 2nd grade, £11 10s. † Porter grains (London), £8 7s. 6d.
‡ Includes barrels. § Porter grains (London), £1 4s. 6d.

We have recently analysed another sample of Soycot cake and found it to contain 100 digestible food units per ton, which is 12 units more than the sample we analysed in December. The composition of the cake has evidently been changed so

as to give a higher analysis, probably by increasing the proportion of soya bean and decreasing the proportion of cotton seed.

Since last month the prices of all feeding stuffs shown in the list have risen, for the most part very sharply, the rises varying from $\frac{1}{2}d.$ to $6\frac{1}{4}d.$ per food unit. The rise is most pronounced in linseed, linseed oil, cotton seed, cotton cake, maize and maize products, feeding barley, oats, Calcutta white peas, Burmese rice meal and feeding treacle. Ground-nut cake and coconut cake have also advanced considerably. Bran and pollards are much dearer, but the prices of other wheat offals are little higher than last month.

TABLE II.

PRICES PER FOOD UNIT. LONDON.

	s.	d.		s.	d.
Brewers' grains (wet) ..	1	3¼	Egyptian cotton seed ..	2	7
Ground-nut cake ..	1	7¾	Argentine maize ..	2	7¼
Malt culms	1	11¼	Maize germ meal ..	2	7½
Maize gluten feed ..	1	11¾	English dun peas ..	2	8
Decorticated cotton cake	2	0	Linseed	2	8¼
Brewers' grains (dried) ..	2	1	American maize.. ..	2	9½
Coconut cake	2	1½	Egyptian cotton cake ..	2	11
Indian linseed cake ..	2	2	English maple peas ..	3	0¼
Wheat middlings ..	2	2½	Bombay cotton cake ..	3	2
English linseed cake ..	2	3¼	English oats	3	2¼
Wheat sharps	2	3¾	Maize meal	3	2¾
English beans (new) ..	2	4¼	Feeding treacle	3	3¾
Chinese beans	2	4¼	Argentine oats	3	4
Wheat bran	2	5½	English feeding barley ..	3	4½
Wheat bran (broad) ..	2	6	Calcutta white peas ..	3	6¼
English beans (old) ..	2	6½	Linseed oil	3	6¼

TABLE III.

PRICES PER FOOD UNIT. LIVERPOOL.

	s.	d.		s.	d.
Ground-nut cake ..	1	5¾	Wheat bran	2	7¾
Soya bean cake	2	0	English beans	2	8¼
Decorticated cotton cake	2	1	Wheat sharps	2	8½
Indian linseed cake ..	2	1¼	Wheat bran (broad) ..	2	9
Coconut cake	2	1¼	Maize meal	2	10¼
Palm-nut kernel cake ..	2	1¼	Egyptian cotton cake ..	3	0¾
English linseed cake ..	2	3½	Argentine oats	3	1½
Argentine maize	2	5¾	Bombay cotton cake ..	3	2½
Wheat pollards	2	6	English oats	3	3½
Maize germ meal ..	2	6¼	Linseed	3	4¼
American maize	2	6¾	Feeding treacle	3	6½
Malt culms	2	7	Linseed oil	3	10
Burmese rice meal ..	2	7¼	Cotton seed oil	4	4¾

TABLE IV.

PRICES PER FOOD UNIT. HULL.

	s.	d.		s.	d.
Brewers' grains (wet) ..	1	5	Egyptian rice meal ..	2	6½
Ground-nut cake ..	1	8¼	Wheat bran (broad) ..	2	6¾
Soya bean cake	1	10½	Egyptian cotton seed ..	2	10½
Malt culms	2	0	Egyptian cotton cake ..	2	11
Brewers' grains (dried) ..	2	1	Linseed	2	11¾
English linseed cake ..	2	2¼	Maize meal	3	0½
Wheat middlings ..	2	2½	English maple peas ..	3	0¾
English beans	2	5½	Bombay cotton cake ..	3	0¾
Argentine maize	2	5½	English oats	3	2¼
Wheat sharps	2	6	Linseed oil	3	4
English dun peas ..	2	6¼	English feeding barley ..	3	6
Wheat bran	2	6¼	Calcutta white peas ..	3	7¾

TABLE V.

PRICES PER FOOD UNIT. BRISTOL.

	s.	d.		s.	d.
Ground-nut cake ..	1	8¾	Wheat sharps	2	6
Palm-nut kernel cake ..	2	0¼	Wheat middlings ..	2	6¼
Maize gluten feed ..	2	0½	Maize germ meal ..	2	6½
English linseed cake ..	2	3¼	Argentine maize ..	2	6¾
Brewers' grains (dried) ..	2	3¼	Linseed	2	8¾
English beans	2	5	Maize meal	2	11
Wheat bran	2	5	Egyptian cotton cake ..	2	11½
Malt culms	2	5¼	English oats	3	1¼
Wheat bran (broad) ..	2	5½	Argentine oats	3	2¾
Egyptian rice meal ..	2	5¾	Linseed oil	3	11¾

TABLE VI.

AVERAGE PRICES PER FOOD UNIT.

	s.	d.		s.	d.
Brewers' grains (wet) ..	1	4¼	Maize germ meal ..	2	6¾
Ground-nut cake ..	1	7½	Wheat bran (broad) ..	2	6¾
Soya bean cake	1	11¼	English dun peas ..	2	7
Maize gluten feed ..	2	0	Burmese rice meal ..	2	7¼
Decorticated cotton cake	2	0½	American maize	2	8
Palm-nut kernel cake ..	2	0¾	Egyptian cotton seed ..	2	8¾
Coconut cake	2	1¼	Linseed	2	11¼
Indian linseed cake ..	2	1½	Egyptian cotton cake ..	2	11½
Brewers' grains (dried) ..	2	1¾	Maize meal	3	0
Malt culms	2	2¼	English maple peas ..	3	0½
English linseed cake ..	2	3	Bombay cotton cake ..	3	1¾
Wheat middlings ..	2	3¾	English oats	3	2¼
Chinese beans	2	4¼	Argentine oats	3	2¾
English beans	2	6	Feeding treacle	3	5
Egyptian rice meal ..	2	6	English feeding barley ..	3	5¼
Wheat sharps	2	6	Calcutta white peas ..	3	7
Wheat pollards	2	6	Linseed oil	3	8
Argentine maize	2	6¼	Cotton seed oil	4	1¾
Wheat bran	2	6¼			

TABLE VII.

(1) Name of Feeding Stuff.	(2) Nutritive Ratio.	(3) Per cent. digestible. Protein.	(4) Fat.	(5) Carbo-hydrates and Fibre.	(6) Starch equiv. per 100 lb.	(7) Linseed Cake equiv. per 100 lb.
Foods Rich in both Protein and Oil or Fat.						
Ground-nut cake	1 : 0·8	45·2	6·3	21·1	77·5	102
Soya bean cake	1 : 1·1	34·0	6·5	21·0	66·7	88
Decort. cotton cake ..	1 : 1·2	34·0	8·5	20·0	71·0	93
Linseed cake, Indian ..	1 : 1·9	27·8	9·3	30·1	77·1	101
Linseed cake, English ..	1 : 2·0	26·7	9·3	30·1	76·0	100
Cotton cake, Egyptian ..	1 : 2·1	15·5	5·3	20·0	40·0	53
Cotton cake, Bombay ..	1 : 2·5	13·1	4·4	21·5	37·6	49
Maize gluten feed	1 : 3·0	20·4	8·8	48·4	87·4	115
Brewers' grains, dried ..	1 : 3·5	14·1	6·6	32·7	50·3	66
Coconut cake	1 : 3·8	16·3	8·2	41·4	76·5	101
Palm nut kernel cake ..	1 : 4·6	12·5	7·7	39·0	69·5	90
Linseed	1 : 5·9	18·1	34·7	20·1	119·2	157
Fairly Rich in Protein, Rich in Oil.						
Maize germ meal	1 : 8·5	9·0	6·2	61·2	81·0	107
Rice meal	1 : 9·4	6·8	10·2	38·2	68·4	90
Rich in Protein, Poor in Oil.						
Peas, Calcutta white ..	1 : 2·1	23·3	1·1	45·9	66·9	88
Beans, English	1 : 2·6	19·3	1·2	48·2	67·0	88
Beans, Chinese	1 : 2·6	19·6	1·7	47·9	67·0	88
Peas English maple ..	1 : 3·1	17·0	1·0	50·0	70·0	92
Brewers' grains, wet ..	1 : 3·5	3·5	1·5	8·6	12·7	17
Malt culms	1 : 3·6	11·4	1·1	38·6	38·7	51
Cereals, Rich in Starch, not Rich in Protein or Oil.						
Barley, feeding	1 : 8·0	8·0	2·1	57·8	67·9	89
Oats, English	1 : 8·0	7·2	4·0	47·4	59·7	79
Oats Argentine	1 : 8·0	7·2	4·0	47·4	59·7	79
Maize, American	1 : 11·5	6·7	4·5	65·8	81·0	107
Maize, Argentine	1 : 11·3	6·8	4·5	65·8	83·3	110
Maize meal	1 : 13·0	5·5	3·5	69·9	77·8	102
Wheat middlings	1 : 5·3	12·0	3·0	56·0	59·1	78
Wheat sharps	1 : 5·0	12·0	4·0	50·0	58·4	77
Wheat pollards	1 : 5·3	11·6	3·5	53·0	54·1	71
Wheat bran	1 : 4·7	11·3	3·0	45·0	49·7	65
Wheat bran, broad ..	1 : 4·7	11·3	3·0	45·4	48·1	63

Suggested Rations for February.—*For Horses.*—The rations which have been recommended in former notes contained a considerable proportion of maize. At the time when they were worked out, maize was one of the cheapest foods on the market. This is no longer the case; indeed, maize has recently become very dear, and is not an economical food to buy at present prices. As a matter of fact, all starchy foods are comparatively dear at the present time, and it is difficult to work out a suitable mixture for horses which contains enough carbohydrates and is reasonable in price. The following mixture is suggested:—

Crushed beans ..	1 part.	Bran, pollards, sharps or middlings, whichever is cheapest locally	1 part,
Dried brewers' grains	1 ,,		
Rice meal	1 ,,		

This mixture contains rather too much protein and not quite enough starchy materials for horses, but this can readily be corrected by giving rather a smaller ration and supplementing it with about a stone per head per day of cut roots. Used in this way it should give good results with horses at ordinary farm work.

For Milch Cows.—For a cow weighing 10 cwt., and giving 2 gal. of milk per day, the following ration is suggested, in addition to an ordinary ration of roots, hay, and straw:—3 lb. of bran and 2 lb. of one of the following mixtures of concentrated foods:—

I. Maize gluten feed, dried grains, coconut cake, and ground-nut cake, 1 part of each.
II. Decorticated cotton cake, 3 parts, rice meal, 2 parts.
III. Ground-nut cake, coconut cake, and rice meal, 1 part of each.
IV. Ground-nut cake, palm-nut kernel cake, coconut cake, and maize gluten feed, 1 part of each.

For each extra gallon of milk 2 lb. of concentrated food, I., II., III., or IV. above, should be added to the ration. The whole ration should also be increased or diminished for cows above or below 10 cwt. live-weight.

For Fattening Bullocks.—For fattening cattle, where roots are plentiful, the ration recommended consists of all the roots and straw the animals will eat supplemented by 3 lb. per head per day of ground-nut cake, which might be increased to 5 lb. as fattening progresses. Where roots are plentiful this ration cannot be improved upon at present prices. The writers have tried it at the Norfolk Agricultural Station with marked success. For the first 2 months, 21 bullocks, of an average live-weight of about 10 cwt., have made live-weight increases of about 20 lb. per head per week.

Where the amount of roots is limited, or the quality of the roots such that the animals will not eat more than about 56 lb. per head per day, it will pay to give more concentrated food. Ground-nut cake, however, contains too much protein to use alone in larger quantity than from 3 to 5 lb. per head per day. Starchy foods suitable for mixing with it are now so very dear that it will pay better to use palm-nut kernel cake alone up to 7 or 8 lb. per head per day, or a mixture of palm-nut kernel cake, decorticated cotton cake, and coconut cake.

For Ewes Suckling on Roots.—The writers have heard good accounts of the following mixture which was suggested last month:—

Ground-nut cake .. 2 parts. Mixed home-grown corn, crushed .. 3 parts.

Cotton cake is now so dear that the writers do not hesitate to recommend this mixture in place of the safer and better-known mixtures advised last month. Cases are known where it has been used with success.

It is advised that the ground-nut cake should be withheld for the first few days after lambing, and then introduced gradually.

The writers have heard of digestive trouble arising from ewes eating from troughs containing the dusty remains of foods with whose properties shepherds are not yet familiar. Many unfamiliar foods are now being used. Some of them leave a dusty residue in the troughs, which gets wet and ferments. Such fermented remains have been found to cause trouble. Sheep owners are, therefore, reminded that it is important to see to the thorough cleanliness of sheep troughs used for foods which are liable to leave a dusty residue.

The writers have been asked about the use of palm-nut kernel cake for sheep, more especially for suckling ewes. Having no personal experience of its use they would be greatly obliged if any reader who has used it for sheep would be good enough to give them the benefit of his experience.

For Lambs and Other Young Stock.—In these notes for November a mixture of 1 part of linseed ground together with 5 parts of maize was recommended as a substitute for linseed cake for young stock. Since that date maize has risen so considerably in price that such a mixture has become more expensive than the linseed cake as a substitute for which it was designed. It is advisable, therefore, to return to linseed cake, which should be used in a mixture with an equal weight of bran, dried brewers' grains, or malt culms.

For Fattening Pigs.—Pigs require foods containing a large proportion of starchy materials. At the present time all foods of this kind are very dear. Barley meal, which is, on the whole, the best food for pigs, costs 3*s.* 6*d.* per food unit, a price which is practically prohibitive. Middlings, sharps, pollards, and rice meal are about 1*s.* per unit cheaper. Where they are available, chats or other unsaleable potatoes, cooked before use, should be used. Working with small quantities, about 5 cwt. of coal will cook 1 ton of potatoes. In reckoning quantities for rations, 4 lb. of potatoes may be taken to be about equal to 1 lb. of barley meal. For fattening stores of about 6 to 8 months old, a weighed quantity of potatoes should be cooked, the water poured away, and the potatoes mashed and mixed with an equal weight of middlings, sharps, pollards, or rice meal, previously

stirred up with enough water to make a suitable gruel so that the cooked potatoes will thicken it to about the proper consistency. Pigs will do well on this until about half fat. For finishing, it is advisable to use a mixture of 4 parts of one or other of the above meals with 1 part of bean meal, which is mixed with the cooked potatoes as before.

For Fattening Newly Weaned Pigs, to come out as "Londoners" or bacon hogs at 7 months. Two parts of potatoes are weighed out and cooked. The cooked potatoes are then mashed and mixed with 6 parts by weight of pollards previously stirred into a suitable gruel with water. Just before feeding, 1 part, by weight, of finely-ground linseed cake is scattered on to the gruel and stirred in. The writers have used this method of fattening young pigs with success.

Notes on Fertilisers in February: *From the Rothamsted Experimental Station.*

THE two great manurial needs of crops at the present time are nitrogen and phosphates: nitrogen to make good the loss of nitrates from the soil, and phosphates to encourage root development, especially on the heavier soils, and to give the plant a vigorous start once it begins growing. These would be needed at any time under similar weather conditions, but they are particularly necessary just now that additional food supplies must be raised in the country. A proper balance must, however, be maintained between them. Farmers who have tried to increase their corn crops and have "done" their land better than usual by giving more ammonia or more dung, or by feeding more cake than usual, should balance this additional nitrogen by a dressing of superphosphate (or, in certain cases, basic slag). This prevents rankness, and hastens ripening, besides improving the quality of the grain.

Nitrogenous Manures.—*Nitrate of Lime.*—This is offered at Hull at 15*s.* per unit of nitrogen, and farmers who are able to obtain it at this price must consider themselves fortunate. In general action it resembles nitrate of soda, and experiments at a number of centres have shown its value as a spring dressing for all crops. It contains approximately the same percentage of nitrogen as nitrate of soda, but in present circumstances it may be used in larger quantities, and it still comes out a cheap manure. The older samples usually tended to become sticky and to store badly, but this difficulty is being steadily overcome. It appears to be free from the disadvantage of making heavy soils work badly.

Calcium Cyanamide, better known as Nitrolim.—This is even lower in price at Hull than nitrate of lime, and at each place where quotations are given it is the cheapest quick-acting nitrogenous manure obtainable. It has considerably improved during the last few years, and the granular form appears to be very promising. It must go on early; late sowing has on several occasions led to bad results; but at any time during this month or next it may be used to advantage.

Sulphate of Ammonia.—This manure ought to be used more freely for cereals. Farmers have long used soot as a top-dressing for wheat. Sulphate of ammonia is the essential fertilising constituent of soot in a concentrated form, and the Rothamsted and other experiments have shown that it is very effective.

Nitrate of Soda.—Nitrate of soda is very high in price, but, even at the present figure, will still prove useful for spring dressings, especially where plants are standing still and suffering from the effects of pests. The soda is of value at the present time as it both liberates potash from the soil and helps to economise the use of potash in the plant.

Organic Manures.—War conditions have brought on to the market a number of organic materials of fertilising value. Some are waste products of manufacturers rendered specially busy by the war; others are fertilisers which used to go to the Continent, but are now kept in this country; some of them pass under the name of guano. Fertiliser manufacturers take up a considerable amount, but farmers also may get an opportunity of obtaining them. They should never be purchased on a mere inspection of the sample. However good the material may look, and however strongly it may smell, a sample should always be drawn and be analysed by the county authority. The trouble and expense are only small, but the value to the farmer is considerable, as he is at once enabled to judge whether or not the manure is worth the money asked.

Phosphatic Manures.—The chief point calling for comment is the high price of dissolved bones. So far as experiments go the soluble phosphate in dissolved bones is no better than in superphosphate, and there is nothing to justify the higher prices asked this month.

Bone meal acts well in many cases, and may be substituted, in the case of arable crops, for basic slag or superphosphate, where deliveries of these cannot be obtained in time. Steamed bone flour is in a finer state than the meal, but no precise experiments have been made to compare them, so that it is impossible

to assert that one is superior to the other. There is no reason to suppose that the nitrogen in steamed bone flour is worth more to the farmer than that in the meal, and nothing to show why he should be asked to pay 2*s.* or 2*s.* 6*d.* per unit more for it, as he is at some places. (See *Unit Prices*, p. 1159.)

Potash Manures.—The need for potash is sure to be felt sooner or later; meanwhile it can be met:—

1. By saving all the ashes from the burning of hedge cleanings and trimmings, dust and other refuse of threshing operations;
2. By applying lime to the soil; and
3. By the use of salt; or of sulphate of soda, which is obtained as a by-product in the manufacture of certain acids used for munitions. It must, however, be analysed before use and *certified free from acidity.* Some samples contain potash: one recently examined at Rothamsted contained as much as 23 per cent., and, as it had been obtained for very little, was a great bargain for the farmer who had bought it.

Suggestions.—In view of the difficulties of transport and of labour it is necessary to get well forward with the arrangements for the spring dressings. The general rules are:—

Sulphate of ammonia, nitrolim and soot can safely go on *early* in the spring.

Nitrate of soda and nitrate of lime can safely be left till later.

Organic manures, such as fish guano, should go on early, but can be harrowed in. Shoddy, however, must be ploughed in.

Bone meal and bone flour should go on early.

Basic slag can be used a little later

Superphosphate and dissolved bones can go on rather later still, and can be applied as top-dressings for winter corn.

Unit Prices of Artificial Manures in February.

THE statement on p. 1159 shows the cost to the purchaser of 1 per cent. per ton of nitrogen, soluble and insoluble phosphates, and potash derived from various sources, at certain ports and manufacturing centres, for February, 1916.

NOTE.—These unit prices are based on the *probable* retail cash prices in bags f.o.r. for quantities of not less than 2 tons of the manures mentioned at the ports and places specified, but it should be borne in mind that market prices are fluctuating considerably at the present time. The prices are published by the Board of Agriculture and Fisheries for use in comparing the commercial values of artificial manures. They may also be used as a guide to the probable price per ton of any of the manures mentioned if the unit prices of the

	London.	King's Lynn	Hull.	Newcastle.	Silloth.	Liverpool.	Widnes.	Newport.	Bristol.	Plymouth.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Nitrogen from:										
Sulphate of Ammonia pure.. 95%	—	—	17 3	16 3	—	—	—	17 6	—	—
" 93%	—	—	17 2½	—	—	18 9	18 9	—	17 8½	17 11½
Calcium Cyanamide ..	—	—	14 6	15 9½	—	14 6	—	16 1½	—	16 1½
Nitrate of Soda 95%	—	—	20 11½	—	—	21 10½	22 7	—	21 9½	—
" pure .. 96%	21 11	—	22 0	—	22 0	—	—	22 4	—	21 8
Nitrate of Lime ..	—	—	15 0	—	—	—	—	—	—	—
Soluble Phosphates from:										
Superphosphate 35%	2 8½	—	2 8	3 0	2 10½	2 9½	2 8½	2 9½	2 9½	2 9½
" 33%	2 8½	—	2 9	3 0½	—	2 9½	2 8½	2 9½	2 9½	2 9½
" 30%	2 9½	—	2 10½	3 2	3 0	2 10½	2 9½	2 10½	2 10½	2 10½
" 26%	3 0½	—	3 1	3 6	—	3 2	3 1	3 2	3 2	3 2
Dissolved Bones.. ..	3 10	—	3 7	—	3 9	4 2	4 0½	3 10½	4 1½	3 11
Allowed for Nitrogen	*21 5½*	—	*20 2*	—	*20 11½*	*23 3*	*22 6½*	*21 10*	*23 1*	*22 0*
Allowed for Insol. Phos.	*2 2*	—	*2 0½*	—	*2 1½*	*2 4*	*2 3*	*2 2½*	*2 4*	*2 2½*
Insoluble Phosphates (Citric Soluble) from:										
Basic Slag	2 7	—	2 0	—	—	2 0½	—	—	2 1½	2 7
Insoluble Phosphates from:										
Basic Slag	—	—	1 11½	1 7½	—	—	—	—	—	—
Bone Meal	1 10½	—	1 9½	1 11	2 2	1 10½	1 10	1 7½	1 8½	1 11
Allowed for Nitrogen	*18 8*	—	*17 7*	*19 0*	*21 3½*	*18 7½*	*18 4½*	*16 2*	*17 0½*	*18 11*
Steamed Bone Flour..	1 11½	—	2 0½	2 1	—	—	—	1 8	1 11	—
Allowed for Nitrogen	*19 4*	—	*20 2*	*20 7*	—	—	—	*16 6*	*19 1½*	—
Potash					No quotations.					

constituents of the manure are multiplied by the percentages of the constituents found in it, and due allowance is made for the difference between cash prices and credit prices, and for cost of carriage from the nearest centre to the place where it is delivered to the purchaser. If used in connection with the valuation of a compound manure regard must be had to the sources of the constituents, and a reasonable sum must be added for mixing, disintegrating and rebagging the ingredients, bags, and loss of weight.

Agricultural Exports in 1915.*

The value of the agricultural articles of British production and manufacture exported amounts in the aggregate to a considerable sum, although, taken individually, such articles do not usually represent a very extensive trade. The unusual conditions brought about by the European war have, doubtless, affected the exports of most of the commodities in 1915. The information available for the past year is summarised in the tables on p. 1161. The various commodities included under the heading of grain and flour represent a total of £3,785,052, while meat of all kinds, including living animals (chiefly cattle) for food, bacon, hams, poultry and game, accounts for £1,344,071. Wool from British flocks was exported to the value of £2,026,463, while hides and undressed skins accounted for £899,150, a great decrease compared with 1914 and 1913.

Three items of importance, viz., manures, cakes, and agricultural machinery, are included in the table, though they are not agricultural products. In the case of manures, 541,931 tons were sent from this country, representing a value of £4,812,008; over one-half of this, viz., 294,308 tons, was sulphate of ammonia, while the balance was made up of 68,735 tons of superphosphate, 117,487 tons of basic slag, and 61,401 tons of other kinds of artificial manures.

As regards oil-seed cake, the exports of this feeding stuff have steadily declined from 175,422 tons in 1910 to 30,125 tons in 1915.

A very large decrease in the exports of agricultural machinery took place in 1915, and the total value of the trade fell to £457,030 compared with £2,313,671 in 1914, and £2,989,186 in 1913.

In normal times perhaps the most interesting item in the export trade, from an agricultural point of view, is that which shows the sales of breeding animals to the Colonies and foreign

* The exports include goods bought in the United Kingdom by, or on behalf of, the Governments of the Allies, but do not include goods taken from British Government Stores and Depots, or goods bought by His Majesty's Government and shipped on Government vessels.

EXPORTS.

Description.		1914.	1915.
Grain and flour	£	3,005,080	3,785,052
Meat (including animals for food)	£	1,139,362	1,344,071
Wool	lb.	38,458,000	32,002,000
	£	2,294,638	2,026,463
Hides and undressed skins ..	£	1,483,108	899,150
Manures	tons	639,115	511,931
	£	4,886,474	4,812,008
Oil-seed Cake	tons	41,566	30,125
	£	265,827	236,055
Agricultural machinery (prime movers except electrical)	£	1,157,661	180,311
,, (not prime movers or electrical)	£	1,156,010	276,719

Description.		Quantity.		Value.	
		1914.	1915.	1914.	1915.
ANIMALS, LIVING—FOR BREEDING:		Number.	Number.	£	£
Cattle	To United States of America	587	373	31,389	12,774
	,, Uruguay ..	192	209	16,631	14,549
	,, Argentine Republic	605	845	69,232	110,101
	,, Australia.. ..	85	54	8,996	4,312
	,, Canada	—	187	—	6,060
	,, Other Countries..	1,016	438	44,434	27,566
	Total	2,485	2,106	170,682	175,362
Sheep and Lambs	To Germany.. ..	316	—	2,926	—
	,, United States of America	722	199	6,664	1,409
	,, Uruguay ..	738	321	11,640	4,958
	,, Argentine Republic	233	1,789	2,696	35,741
	,, Australia.. ..	48	85	2,436	1,471
	,, New Zealand ..	—	45	—	1,474
	,, Canada	427	140	2,748	808
	,, Other Countries..	540	454	6,875	6,190
	Total	3,024	3,033	35,985	52,051
Swine	To Argentine Republic	3	12	15	185
	,, Canada	—	2	—	27
	,, Other Countries..	411	114	5,384	1,191
	Total	414	128	5,399	1,403
HORSES:					
	To Netherlands ..	10,392	9	87,596	615
	,, Belgium	19,205	—	363,486	—
	,, France	1,299	341	102,219	62,391
	,, Other Countries..	6,810	1,192	511,721	256,998
	Total	37,706	1,545	1,065,022	320,004
ANIMALS OF OTHER KINDS—Not for food		32,336	17,924	48,561	27,882

countries. Particulars of this trade for the past two years are given in the table on p. 1161. During the latter part of 1914 and throughout the whole of 1915 the trade was adversely affected by the war to a large extent.

In 1915, despite the fact that a smaller number of cattle were exported from this country than in 1914, the total value was slightly higher in the former year than in the latter. In the case of sheep and lambs, also, although the number exported was almost identical in both years, the value in 1915 amounted to one-half as much again as that of 1914.

As regards the export of horses, the trade in 1915 was to a great extent suspended, the number of animals being 1,545, against 37,706 in 1914 and 68,632 in 1913. Such trade as was carried on, however, was apparently in animals of considerable value, the average price per horse in 1915 being about £207, compared with £28 in 1914 and £26 in 1913. It may be of interest to mention that the average prices paid per horse in 1915 were: by Holland £68, by France £181, and by "other countries" £216.

Destruction of Farm Vermin.*

In view of the necessity for maintaining the supply of home-grown food, efforts must be made to reduce the damage done by rabbits, rats, sparrows, rooks, wood pigeons, and other forms of farm vermin.

The principal methods of destroying the more troublesome forms of vermin are indicated in the present article, while further information as to the best methods of dealing with house sparrows and rats is given in Leaflets Nos. 84 and 244 respectively.

Rats. — Rats are responsible for more waste on many farms than any other kind of farm vermin. They will not remain, or increase in places where food is not easily procured, and therefore, so far as possible, all buildings and receptacles for food should be made rat-proof, and waste food should not be left in stables, cow-houses or poultry runs. Garbage and refuse of all kinds which might harbour rats or provide food for them should be burnt or otherwise disposed of. When farm buildings are properly looked after and cats are kept, rats seldom increase rapidly.

* This article is a reprint of Special Leaflet No. 52, recently issued. Separate copies of the leaflet will therefore not be sent to subscribers to the *Journal* unless specially applied for.

When rats are present in numbers, systematic and persistent efforts should be made to destroy them. Three main methods may be employed :—

(1) *Hunting.*—The rats may be ferreted out and killed with dogs, sticks and the shot gun. When corn ricks are thrashed a special endeavour should be made to kill every rat turned out. The rats may be caught with greater certainty if the ricks are surrounded with galvanised iron sheeting or wire netting, 4 ft. in height, sloping towards the ricks.

(2) *Traps.*—In addition to the spring trap, the wire trap on the eel-basket principle, the sunk pit or well trap, and the large barrel trap with slit paper or hinged wooden cover may at times be found effective. For a description of these traps reference should be made to Leaflet No. 244 (*The Destruction of Rats*).

(3) *Poisons and Fumigants.*—Rat poisons are to be obtained from most chemists, and are likely to be effective if the appearance and form of the bait are varied at intervals. The chief objection to the use of poisons is the possibility of injury to other animals. According to a note in the *Scottish Farmer* (2nd October, 1915), the following method has been found effective and safe :—Shallow trenches are dug about 12 to 14 in. long and 4 in. wide, and covered over with a board, straw or sticks. A mixture made up of 1 oz. of the coarsest moist sugar with 4 oz. of dry flour, oatmeal or barley meal is then left in the trench each night until the rats eat it readily. The process is omitted for one night, and the following night 1 oz. of finely powdered barium carbonate is thoroughly incorporated with the mixture. As the whole mixture is in a dry state the rats cannot carry it away, but eat it on the spot. *See also* Leaflet No. 244.

In the case of burrows in the open, fumigation with carbon bisulphide may be employed. A large wad of cotton wool, rag, or similar absorptive material should be soaked with the liquid and at once inserted in one of the main burrows, and the outlets and inlets closed up. Care should be taken in using the bisulphide, as it is both poisonous and highly inflammable, and no light of any kind should be brought near it. As the bisulphide is heavier than air the wad should be inserted at the highest point of the burrows, so that the vapour moves steadily downwards.

Mice.—Mice often do considerable damage in gardens by destroying peas and other seeds. To protect peas against the attacks of mice the seed should be steeped in a solution of

bitter aloes (1 oz. to 2 quarts of water) and allowed to remain for a night before sowing. Ordinary baited mouse traps placed near the rows will also be found useful.

Sparrows.—In the case of many birds there is room for doubt as to their true economic position in relation to agriculture, but in the case of the sparrow there is none. Sparrows do most damage during the few weeks before harvest. Later on they live mainly round dwelling houses, taking grain from the stacks and poultry yards and various waste material. Their depredations, however, are not confined to grain crops, and they do much damage among garden crops.

To reduce the numbers of sparrows their eggs and nests should be destroyed in the breeding season. On dark nights the birds may be driven into nets from their roosting places, in ricks, hedges, or ivy-clad houses. Shooting with small shot during frost or snow, when the birds are readily attracted by grain, is useful, while combined action of the kind indicated in Leaflet No. 84 is especially valuable.

Rooks and Larks.—These birds often do much damage to sprouting autumn-sown corn, especially wheat. Where they are unusually troublesome some farmers adopt the plan of stringing whole fields with cotton. Treating the grain with preparations of tar and petroleum (a pint of coal tar thinned down with paraffin to 6 bush. of seed afterwards dried with powdered lime) has met with success in some cases, and it is claimed that naphthalene mixed with sawdust and distributed over the surface of a newly-sown field will keep all birds away for some time.

The following plan is considered by some to be effective in the case of the rook: immediately the seed is sown and before the rooks have discovered it, the carcass of a rook is torn to pieces and distributed over the field (a few dead rooks will be sufficient for a considerable area). As a general measure to keep down the numbers of rooks, rookeries may be raided at nesting time, but as the nestlings are largely fed on insect food it would be well not to destroy the rooks until the young are nearly ready to fly.

Wood Pigeons.—In many districts wood pigeons prove a most troublesome pest to the farmer and take large quantities of grain, cabbages, turnips, clover leaves, etc. Wood pigeons may be kept down by shooting and trapping. The best time for shooting is at sunset and before dusk when the birds are coming back to roost, or they may be shot at

their feeding places. The shooter should be in some prepared shelter such as a conical hut of branches or a covered shelter in a ditch or hedge. Decoys will also be found useful; these may be stuffed birds placed on branches of trees, or newly killed birds in cases where the shooter is lying in wait at some feeding place in a stubble or turnip field.

Rabbits.—Rabbits do most damage to young crops, especially to late-sown corn, turnips, and cabbages. Where farmers are unable to keep down rabbits by shooting, wire netting may be resorted to, or ferrets, nets and snares may be used. The snares should be of the form recommended in Leaflet No. 228 (*Prevention of Cruelty to Animals*).

Where rabbits are a pest in gardens, the only effective remedy is to erect a fence of wire netting right round the garden; the netting must be let into the ground to a depth of 6 in. and bent outwards.

Foxes.—Although the various Hunts will no doubt take what measures they can to reduce the number of foxes in their respective districts, poultry keepers may still sustain much loss among their stock owing to the depredations of foxes. Where foxes are bold and determined it is difficult to suggest any really effective means of keeping them away. A little asafoetida sprinkled about once a month round the entrance to each poultry-house and round each gap in the fence or hedge where the animals enter the field is said to be effective, while wire netting, especially if roughly brushed with tar, will often act as a deterrent. As a precautionary measure care should be taken that the fowls are safely secured in their houses at night.

Need for Combined Effort.

The destruction of vermin is essentially a matter for local effort, but this should not be isolated or unsystematic. The most determined efforts to keep down the numbers of vermin on a particular farm may be of little avail if the pests are allowed to multiply on neighbouring farms. Occupiers of farms or buildings should therefore join together with a view to making a systematic attempt to reduce the pests over as large an area as can be conveniently dealt with. Clubs similar to those suggested in Leaflet No. 84 for the destruction of sparrows might be formed, and local agricultural and horticultural societies of all kinds should take advantage of their favourable position for initiating concerted action among their members, and introduce schemes for the destruction of vermin.

Land Settlement for Sailors and Soldiers.

ON the 15th July, 1915, the President of the Board of Agriculture and Fisheries appointed a Committee, under the chairmanship of Sir Harry Verney, to "consider and report what steps can be taken to promote the settlement and employment on the land in England and Wales of sailors and soldiers whether disabled or otherwise, on discharge from the Navy or Army."

The Committee presented an Interim Report on 4th September, 1915, recommending that a free course of training at an agricultural college should be given as an experiment to 50 disabled sailors and soldiers, with a view to obtaining for them permanent employment on the land, and in the case of those proving specially capable, fitting them to become occupiers of small holdings.*

The recently issued Final Report (Introduction and Part 1) [Cd. 8182; price 6*d.*] commences by assuming it to be the agreed policy of the Government to increase both the agricultural population of the country and the supply of home-grown food; and, further, that the attainment of these objects can and ought to be promoted by attracting to the land suitable ex-Service men at the end of the war, provided always this can be done with a reasonable certainty that the men will make a good living on the land when they get there.

The Committee refer to the extent to which the defensive power of a country is strengthened by its capacity to produce food for its inhabitants, and to the danger of an undue dependence on foreign sources of food supply. There is also, so they state, general agreement that on economic grounds it is a matter of the greatest importance to increase the production of food in this country, and so reduce the amount which has to be imported from abroad. The desirability of maintaining the stability and physical strength of the nation is further adduced as a reason for encouraging as large a proportion as possible of the population to live on the land.

The demobilisation of the Navy and Army at the close of the war will, the Committee state, afford a unique opportunity of developing agriculture in this country, an opportunity which it is of the utmost importance to the welfare of the nation should be seized and turned to the greatest possible advantage. The Committee consider two classes of men: (1) Those employed in agriculture prior to the war, and of whom it is urgent that as many as possible should be induced to resume agricultural life at home, and (2) those formerly engaged in urban industry who will be reluctant to return to their former life, and who, seeking opportunities for an open-air occupation, will be attracted to the overseas Dominions, or even lost to the Empire if no such opportunities are open to them in this country.

The Committee divided their enquiry into two parts: (*a*) the settlement of men in holdings of their own, whether as proprietors or tenants, and (*b*) the employment of the men at wages, with or without a bonus or share in the profits, upon the farm or holding of another person. "Employment" is the larger problem, but "settlement" being the more immediate, the Committee devote to it the Report under notice.

It is postulated that the establishment of small holdings involves the application of more capital and more labour to the land than is

* Further particulars will be found in this *Journal* for November, 1915, pp. 813 and 814.

the case with large occupations, and that it will result in more intensive cultivation, greater productiveness and a substantial increase of the population engaged on the land. The Committee recommend, therefore, (*a*) that the State, acting through the Board of Agriculture and Fisheries, should undertake the provision of land for all suitable ex-Service men who desire fully-equipped and self-supporting small holdings, and who are prepared to settle in the places where land can be provided, under the conditions that the State considers necessary to their success. (*b*) On the other hand that the county councils, acting under the Small Holdings Act (with suggested amendments), should provide for any suitable ex-Service men who are not prepared to move to the State Colonies, or who desire accommodation holdings to be worked in conjunction with some other business.

The Committee couple with these recommendations the need for the provision for both expert agricultural advice and business organisation (especially co-operative marketing) as essential to the success of any scheme.

(*a*) *Settlement by the State.*

The Board, it is recommended, should be empowered to acquire land either by purchase (voluntarily if possible, but, failing this, compulsorily) or lease (voluntarily only). Settlement on the "colony system" is regarded as the only system possible for the State, owing to the impracticability of providing isolated holdings all over the country, and of arranging for the necessary expert guidance and business organisation; with the colony system it is possible to develop the social side of the life, and, further, larger blocks of land would be obtainable at lower prices *pro rata*.

With the *caveat* that the size of the colony must depend on various considerations, the Committee consider that the ideal settlement would be a village community of at least 100 families all interested in the cultivation and development of land, but including amongst them those engaged in the trades subsidiary to agriculture. The *minimum* acreage to be taken for a fruit and market garden settlement should, it is stated, be 1,000 acres, and for settlement on dairying or mixed holdings 2,000 acres (these figures excluding any rough or poor land which may have to be purchased as part of an estate). Larger areas will reduce the cost of management and will be an advantage from the point of view of collective marketing.

The Committee recommend that no land should be purchased or leased which is not fairly productive, kind, and easily worked; it should, as far as possible, be of similar quality throughout for each training colony (especially for fruit farming).

Types of Holding.—The fruit and market garden holding is recognised as being, on the whole, most suitable for men with little or no previous experience of agriculture; (*a*) it can be made to produce a larger return per acre than other types of cultivation, (*b*) a larger number of such holdings can be created on a given quantity of land, (*c*) an inexperienced man can be trained more easily to grow these crops, and (*d*) the planting of fruit trees, bushes, &c., could be undertaken by the State, and the cost included in the rent, so that a man could enter into occupation without having to pay a heavy ingoing, and would not have to find much capital for stocking the holding.

The home producer having a practical monopoly of milk the Committee state that they would like to see a large increase in the number

of small grass holdings; the greater risk attaching to dairying, and the need for greater aptitude and experience, and the much greater cost of stocking such a holding are alluded to. It is suggested that the Board should carefully test an arable dairying holding of 25 acres of which the staple products would be milk, pigs, poultry, cereals, and roots, lucerne being used instead of grass.

The small mixed farm of from 35 to 50 acres, comprising both arable and grass land, is not recommended for ex-Service men until they have gained a very varied knowledge and considerable experience.

Poultry farming is not recommended as a staple occupation.

Ownership or Tenancy.—This question is discussed at considerable length, and the conclusion is reached that, for the purpose in view, a system of tenancy is preferable to one of ownership. From the point of view of the State the reasons adduced in favour of tenancy are that effective supervision and control can be exercised, and that the preservation of small holdings, as such, can be assured, once they are created. From the point of view of the small holder the important advantages are greater mobility of tenancy (occupying ownership being a real impediment in the way of a man who desires to rise), and ability to employ the capital available in the stocking and working of the holding (instead of sinking part in purchase). Applications for the purchase of holdings, during the seven years in which the small Holdings Act has been in operation, have been very few in number.

Selection and Training of Tenants.—While applicants with experience and capital might be allowed to take holdings at once, and would serve as examples of their success, it is considered necessary that men with little or no previous experience should be given some preliminary training. The Committee's plan is that these men should be temporarily employed at a weekly rate of pay on a colony established by the State, until they acquire sufficient experience to justify making them tenants. Under this plan the Board would appoint a manager to conduct the land acquired as a large farm, and the men without experience would be offered employment at a weekly wage, together with a cottage and garden. With the acquisition of experience a portion of the farm near their cottages should be let to them, provision being made in laying out the farm so that adjoining land could be added in course of time.

Special consideration should, it is stated, be given to the capacity of the men's wives to assist in the work, and to their willingness to settle on the land. In connection with the training of such women the Committee concur in the recommendations of the Rural Education Conference (see this *Journal*, December, 1915, p. 859 *et seq.*).

Equipment and Adaptation.—The recommendation is made that the property acquired by the State should be gradually developed in accordance with a carefully prepared plan. To illustrate this a map is published showing how an area of 1,000 acres could be developed so as to provide 112 small fruit and market-garden holdings, together with additional land for extensions of the holding and a central farm.

To reduce the initial cost of equipping small areas of land with houses and buildings it is thought that the Government might hand over to the Board, free of cost, the military hutments erected all over the country, the best of which could readily be taken down, re-erected, and adapted in such a way as would convert them into comfortable and suitable rural cottages, or which could also be adapted for use as farm buildings, outhouses, etc.

The Committee state that the equipment of the colony should include, in addition to the houses and buildings required for prospective small holders, a depot and store to be used in connection with the sale of requirements and the disposal of produce, a central club room, and other buildings, such as a jam factory, creamery, etc., as may be found desirable. A private telephone system is suggested.

Any necessary works of road making, water supply, drainage, fencing, &c., should, it is stated, be carried out by the Board, and in the case of a fruit and market-garden colony, part of the land to be allotted in small holdings should be planted with fruit trees and bushes as soon as possible after the land is acquired, so that when the tenants enter into possession they will find their holdings ready stocked.

Provision of Expert Guidance.—The plan of the Committee is that there should be a resident director (at a salary of £500 a year, with house) on each colony who would be responsible for the management of the estate while farmed as a whole, for supervising the instruction of the settlers during their initial period of training, and for advising the small holders as to the cultivation of their holdings, the purchase of their requirements and the disposal of their produce. In addition, the Committee state that it would be necessary to have a practical agricultural, or, in the case of a fruit or market-garden colony, a horticultural instructor who would be responsible under the director for the actual training of the men, and whose salary, it is thought, might be £120 a year with house.

The colony could draw on the agricultural instructors of the county council for instruction in special branches, and on the staff of the provincial council for agricultural education on questions involving scientific research. The establishment of demonstration holdings run on a commercial basis is recommended; special emphasis is laid on systematic instruction in book-keeping.

Co-operation.—The Committee realise that co-operation among the small holders can only result from education, and must have time for growth. They think, therefore, that it will be better to begin by setting up, under the control of the director, an organisation which can collect their produce, dispose of it to the best advantage, and pay them the proceeds, less expenses and a reasonable commission. The Committee hope that, as the small holders acquired experience, realised the advantages of collective dealing, and became educated in the principles of co-operation, they would become capable of taking over the control of the organisation, and running it as a co-operative society.

It is recommended, therefore, that in each fruit and market-garden colony a depot should be established for the produce of the colony, which should be collected, graded, packed, and despatched to market. The depot should be under the control of the director, who would be in touch with all the markets. Similar arrangements are recommended in other types of colonies. In connection with the depot it is thought that provision should be made for dealing with any surplus produce, which could not be sold, by the establishment of a jam factory, pulping and drying plant, a creamery, a cheese factory, etc.

Besides this sale depot a store is recommended for the purchase or hire by the small holders of tools, feeding stuffs, etc., and facilities should, it is stated, be provided whereby the small holders could obtain the use of the larger farm implements and machinery, and the hire

of horses and extra labour. For this purpose the retention of part of the colony as a well-equipped central farm is recommended.

Provision of Working Capital.—The Committee reject the proposal that the State should make direct advances of working capital to ex-Service men who desire to take up small holdings. Instead, they make the following recommendations :—

(1) They think that the burden of tenant-right, which is often a severe tax on the resources of small holders, can be eased on the State colonies. An incoming tenant should not be required to take over hay or straw in excess of his actual needs ; the cost of planting in the case of a fruit holding could properly be treated as a permanent improvement and spread over a period of years, and the Board, on the recommendation of the director of the colony, might be given a discretionary power to defer payment in full in cases where they are satisfied that such a course is justifiable.

(2) With regard to the cost of maintenance of the small holder and his family until a return is got from the holding the Committee suggest that arrangements should be made for tenants to enter at such a time that they will be able to obtain a return without a long interval.

(3) The lack of capital for purchasing the stock, implements, etc., for the holding is met by the Committee's scheme of starting the ex-Service men as labourers at a weekly wage, and gradually adding to the men's land as they became skilled. In this way the principal need will be for small advances for industrious men towards the purchase of a pig, a calf, or, later on, a cow or two, and the Committee think this need should be met by the establishment of a co-operative credit bank in connection with each colony.

As an experiment it is recommended that the State should set aside a small sum of money to be lent to credit banks so set up. 5*s.* an acre is suggested as the amount. The residents should be invited to take up shares and deposit their savings with the society. Limited liability is suggested, with State guarantee of members' deposits.

Social Amenities.– In addition to recommendations as to social amenities, educational facilities, and places of worship, the need for opportunities of subsidiary employment is alluded to.

Rents.—In order to place their scheme on a sound economic basis the Committee would have sufficient rents charged to meet the interest on the cost of the land and the equipment, the statutory outgoings, and a reasonable allowance for repairs, insurance, management, etc. The cost of the educational staff of the colony would not be charged on the rent.

The Committee estimate that the rent of a small fruit and market-garden holding of 4 acres, provided with a cottage, pigsty, fowlhouse and tool shed, and with 1½ acres planted with fruit trees and bushes, would be about £24 a year, and that additional land without equipment could be let at a rent of from £2 to £2 10*s.* an acre, so that the rent of a 10-acre holding would be from £36 to £40 a year. The rent of a dairy or mixed holding of 25 acres provided with a cottage and the necessary buildings would be about £74 a year, if the land was purchased at £40 an acre ; and additional land without equipment could be let at a rent of about £2 2*s.* an acre.

After outlining their scheme the Committee refer to the need for prompt action ; and they recommend that immediate steps should be taken by the Board to acquire and equip land for three pioneer

colonies (illustrating the different types of holding), comprising 5,000 acres in all, and that additional land should be acquired for the settlement of further colonies.

From estimates given by the Committee it appears that the cost of establishing the three pioneer colonies would not be more than £334,000, viz., £215,000 for the cost of the land, and £119,000 for the cost of equipment, tenant-right, and farm capital (it is assumed that military hutments will not be available). The three pioneer colonies are not likely to accommodate more than 300 families. To provide for at least 4,000 or 5,000 families a sum of £2,000,000 should, it is recommended, be placed at the disposal of the Board.

(b) Settlement by County Councils.

The Committee anticipate that county councils will experience a largely increased demand for small holdings when the war is over, quite apart from the applicants who will be provided for in the State colonies; and it is to be expected that many applicants who are ex-Service men will wish to settle in the neighbourhood whence they came, and will probably not be prepared to go to the State colonies.

It is recommended, therefore, that county councils should undertake the provision of small holdings for such men, and that as far as possible they should establish colonies similar to the State colonies outlined above. To this end the Public Works Loan Commissioners should, it is stated, be authorised to resume the issue of loans to councils for the purchase and adaptation of lands for small holdings.

It is further recommended that the Small Holdings Act should be amended so that the Board may become partners with the county councils in the whole business of providing small holdings under the Act, and may pay half of any losses that may be incurred.

The Committee think that it would be an additional inducement to county councils to establish colonies rather than isolated holdings if the Board were authorised to contribute towards the salary of a resident instructor, and towards the initial capital cost of providing a central depot, store, jam factory, creamery, or other similar organisation, for any colony created by a county council. If the military hutments are handed over to the Board, some of these, it is thought, might be placed at the disposal of county councils for colony purposes.

Other amendments suggested to the Small Holdings Act are that:—

(1) Councils should be given the same powers to improve and manage their property as are possessed by trustees of a settled estate.

(2) The maximum term of 50 years for loans for buildings on small holdings should be extended to 60 years.

(3) Buildings erected under the Act with the approval of the Board should be exempted from local by-laws.

(4) Provision should be made to deal with the grievance of the tenants of small holdings that they have to pay in their rents for the purchase of the land.

(5) Section 41(3) should be repealed.

(6) The powers of county councils to acquire land for the purpose of providing small holdings should be extended to the purchase or hiring of land for the purpose of leasing it to a parish council for sub-letting it in allotments.

The Case of Disabled Men.

The Committee are strongly opposed to the segregation of disabled men, or to anything like the establishment of colonies for cripples.

Committees established under the Naval and Military War Pensions Act, 1915, are responsible for training and finding employment for disabled men, but in the present Committee's view it is undesirable that the State or county councils should deal with the settlement on the land of able-bodied men, and that another authority should deal with disabled men; and the Committee think, therefore, that any disabled men who desire to settle in State colonies should be sent on to the Board, while the men who desire local small holdings should be referred to their proper county councils.

Adequate funds should, it is recommended, be provided by the State for the training of disabled men who desire to settle on the land; and such training should be given by the Board on behalf of the Statutory Committee under the Naval and Military War Pensions Act.

It is recommended that, after being trained, disabled men should be treated on the same footing as able-bodied men, except that in selecting tenants of small holdings they might be given the preference if other things are equal.

Finally, it is recommended that a propagandist campaign in favour of land settlement at home should be undertaken by the Board with the assistance and co-operation of the Admiralty and War Office prior to the demobilisation of the Navy and Army.

Report of the Development Commissioners, 1914-15.

In their Report for 1914-15 [H. C. 408, 1916] the Development Commissioners explain that the effect of the war on the sphere of their operations has, so far, belied immediate expectations; the anticipations of unemployment on an extensive scale were falsified and the initial policy of the Commissioners of encouraging the submission of schemes of land drainage, afforestation, &c., was replaced by the discouragement of works employing labour suitable for enlistment. An exception was, however, made by the Commissioners in the case of fisheries as being of great value towards helping the home food supply.

The curtailment of the expenditure from the Development Fund upon fresh schemes did not diminish the activities of the Commission so much as might at first appear, since, firstly, a number of schemes had been established with a reasonable expectation of continued help from the Development Fund, and secondly, there is likely to be a widespread demand after the war for labour-employing works. Under the first head the Commissioners usually recommended just sufficient advance to secure continuity; and in the second case they devoted themselves to the initial stages and projects of development which would, in their execution, have the effect of employing labour on a larger scale and to exploring preliminary engineering, administrative and legal questions which delay the actual start of work. For the purpose of removing difficulties in the way of land drainage schemes, the Land Drainage Act, 1914, was passed.

The general effect of the war upon agriculture, and the probable position of agriculture after the war engaged the Commissioners' attention; the chief question for immediate consideration was the increase of the home food supply, and considerable advances were recommended in aid of schemes for the increase of the production and preservation of food commodities. The provision at the end of the war

of opportunities of agricultural work on a large scale, and upon conditions calculated to satisfy men who have been serving in the army, was also kept in view.

The following more detailed account of the action of the Commissioners relates to England and Wales only.

Agricultural Research and Education.—After the outbreak of war it was decided by the Commissioners, with the consent of the Treasury, that the work of the newly founded Research Institutes should, so far as possible, be maintained, having in view their importance for the future development of agriculture. Some continuity has in this way been preserved at each of the institutes. Since, however, a large proportion of the men engaged have volunteered for active military service, and have been replaced in some cases by voluntary workers, considerable reductions have been made on the expenditure involved. For the continuance of the scheme in England and Wales during 1915-16 the Commissioners recommended the following grants to the Board of Agriculture and Fisheries :—

	£
Grants to Colleges and Institutions in aid of—	
(*a*) Scientific Research and Experiment	27,247
(*b*) The extension of Advisory and Local Investigation Work	9,550
(*c*) Special Investigations and Research	2,900
Research Scholarships in Agricultural and Veterinary Science	4,650
Expenses of Administration	1,100
	£15,447

Apart from the maintenance expenses of research and other work carried on at universities, research institutes, and agricultural colleges, additions are, in many cases, necessary to buildings and equipment before that work can be properly done, and some capital advances had already been made to assist agricultural institutions to obtain better accommodation and more adequate equipment. During 1914-15 the Commissioners recommended the following grants for similar purposes on the basis that only 50 per cent. of the total expenditure necessary is met from the Development Fund, the other 50 per cent. being provided by the institution or otherwise locally :—

Bristol University.—Supplementary grant of £1,250 in aid of the buildings required for a Research Institution in fruit growing.

Leeds University.—Grant of £12,000 in aid of the cost of the erection and equipment of a new building for the University Department of Agriculture.

Rothamsted Experimental Station.—(*a*) Grant of £6,000 in aid of the erection of a new laboratory.

(*b*) Supplementary grant of £986 10s. in aid of the erection of new farm buildings and the extension of the laboratories.

Seale-Hayne Agricultural College.—Supplementary grant of £1,825 in aid of the provision of college buildings.

South-Eastern Agricultural College, Wye.—Supplementary grant of £500 in aid of the erection and equipment of new college buildings.

The necessary complement of this scheme for encouraging research, and providing technical advice through universities and colleges is an extension of a simpler and more immediately practical type of agricultural education, and a considerable addition to the existing provision of help and advice of a less purely scientific kind. For this purpose the Commissioners had already recommended grants for the establishment and extension of farm institutes. The Board of Agriculture applied for a grant of £63,500 to meet expenditure for this purpose during 1915-16, and stated that considerable developments had taken

place notwithstanding that in some counties schemes which were under consideration in the spring of 1914 for the purchase of land for farm institutes, or the appointment of additional staff, have been postponed until the end of the war. A grant of £43,500 was made, and the Commissioners asked the Board to use every effort to induce Local Education Authorities not to proceed with their building schemes during the war. A grant of £1,500 was also made to the Board in aid of the expenses during 1915-16 of the advisory councils established in connection with the Board's scheme for the development of agricultural education and the improvement of live stock.

Shortly after the outbreak of war the Commissioners received a request, made on behalf of the Central Committee on Women's Employment, for assistance in starting the rural industries of vegetable drying and fruit canning (with pulp and jam-making subsidiary to it). A large and immediate demand, owing to the war, existed for the products, and it was believed that these industries offered a new and hopeful opening for demonstration and experiment, as well as for the employment of women and girls. The Commissioners recommended a grant to the Board of such sum as may be required not exceeding £3,000 for the necessary plant and working capital. Experiments are being undertaken in two factories in Warwickshire under the supervision of a Committee appointed by the Board in order to test the prospects of these industries on a commercial scale. It is hoped that when these industries have passed the experimental stage, they may be taken up in the locality and elsewhere on a co-operative basis.

Later in the year the Commissioners recommended a further grant to the Board of £3,000 for 1915-16 to enable them, in consultation with the Commissioners, to assist emergency schemes of an educational or quasi-educational character. Advances from this grant have already been approved for the instruction of women in milking and other light farm work, the establishment of a number of migratory cheese schools, and a scheme for augmenting the production of eggs and poultry.

Poultry Improvement.—The following grants were made :—

(1) £708 to the Utility Poultry Club for the extension of Major Hurst's Burbage experiments in 1914-15.

(2) £125 to the club towards the working expenses of a 10 months' laying competition beginning in October, 1914.

(3) £120 to the Board of Agriculture and Fisheries for the purpose of an experimental scheme during a period of one year, in two counties in England and one in Wales, for the supply of eggs for hatching to cottagers and small holders.

Cultivation and Preparation of Flax and Tobacco.—The Commissioners recommended a grant to the British Flax and Hemp Growers' Society of £2,600 for the continuance of its work in the year 1914-15. A grant of £3,000 was also made to the University of Leeds for the continuation during the year October, 1914, to September, 1915, of the investigation into the cultivation and treatment of flax conducted at Selby by the University.

The Commissioners recommended a grant of £5,000 to the British Tobacco Growers' Society in aid of its work during the year 1914-15, as they were satisfied that the work of the Society promises useful results in the way of definite information as to the commercial conditions and possibilities of the crop.

Horse and Live Stock Breeding.—The following grants for these schemes during the year 1915-6 were recommended to the Board of Agriculture and Fisheries :—

(*a*) £26,500 in aid of light horse breeding in England and Wales.
(*b*) £40,400 in aid of the scheme for the improvement of heavy horses, cattle, and swine, the extension of milk recording, and the employment of live stock officers at Agricultural Institutions in England and Wales.

Co-operation among Agriculturists.—A Joint Committee of the Development Commissioners and the Board of Agriculture and Fisheries was appointed to consider and report upon an application by the Agricultural Organisation Society for the continuance of grants, but in order that the Society might be able to carry on its work pending the completion of the enquiry, the Commissioners recommended a grant, not exceeding £4,000, in aid of its work during the half-year ended 30th September, 1914. In November, 1914, a report was made by the Committee, whose conclusions were accepted by the Commissioners, and a further grant, not exceeding £5,000, was recommended for the year 1914-15. The total grant for the year was made upon the same basis as the grant for 1913-14, viz.: a grant of £6,000, and a further grant equal to the subscription income of the Society for the year, but not in any case exceeding £3,000. Certain recommendations in detail as to the conduct of the business of the Society were made by the Joint Committee, and have been accepted by the Governors of the Society. The Society has been informed that it must not expect a continuance of the grant upon the same basis indefinitely, and that it should make every endeavour to render the movement far more self-supporting.

Forestry.—Assistance from the Development Fund has been given for the past 3 years in support of a scheme which provides instruction and advice at 5 centres in England and Wales (Oxford, Cambridge, Cirencester, Bangor and Newcastle), and provides also for research work and minor forestry experiments. The application of the Board of Agriculture and Fisheries for a grant of £7,200 to continue this scheme during 1915-16 was under consideration at the close of the year.

The following advances were recommended:—

(*a*) £800 to the Commissioners of Woods, &c., as a further capital grant in aid of the scheme for utilising Dean Forest and the adjoining woodlands as a demonstration area;
(*b*) £100 to the Commissioners of Woods, &c., to meet the salary and expenses of an officer employed temporarily for special emergency work at Dean Forest consequent upon the war;
(*c*) £150 to the Board of Agriculture and Fisheries for the provision of three scholarships to enable students at woodmen's schools to proceed for one year to a centre for higher training in forestry;
(*d*) £500 to the English Forestry Association to assist work in obtaining information and organising supplies of timber for collieries and other industries.

Reclamation and Drainage of Land.—In view of the desirability of getting labour-employing schemes ready to put in operation at the end of the war, the Commissioners devoted considerable attention to the preliminary stages of schemes of land drainage in East Anglia, particularly in connection with rivers flowing into the Wash. The Land Reclamation Society has been constituted, and a grant of £350 was made to it for preliminary expenses in connection with an area in Merionethshire. A further advance of £1,000 was made towards the reclamation scheme at Methwold carried on by arrangement with the Duchy of Lancaster.

SUMMARY OF AGRICULTURAL EXPERIMENTS.*

SOILS AND MANURES.

Influence on Crop and Soil of Manures Applied to Permanent Meadow (*Jour. Agric. Science*, September, 1915; *C. Crowther and A. G. Ruston*).—A comparative test of different systems of manuring meadow land has been carried on continuously and uniformly since 1899 at the Manor Farm, Garforth; precisely similar tests were made for several years at five other centres in the West Riding of Yorkshire. The soil is a light loam very poor in lime in a district of medium rainfall (20–25 in.).

The chief conclusions drawn from the results are as follows:—

1. Although the heaviest crops have been obtained with an annual application of dung, they are little heavier, and more costly to obtain, than the crops obtained with a biennial application of dung especially if in the alternate year a light dressing of "artificials," including nitrate of soda, be given.

2. A complete mixture of "artificials," including nitrate of soda, has given good average crops, but not equal to those given by a biennial application of dung.

3. For the soil and other conditions of Garforth, nitrate of soda is distinctly better for the hay crop than sulphate of ammonia. This is doubtless largely associated with the poverty of the soil in calcium carbonate.

4. The different manurings have effected marked and characteristic changes in the botanical composition of the herbage. In particular, the continued use of ammonium salts has led to serious deterioration.

5. There are now differences also in the chemical composition of the herbage, which probably represent substantial differences in feeding value. For equal weights, the hay grown with dung appears to have a lower feeding value than that grown with a good mixture of "artificials."

6. The composition of the ash of the hay does not reflect the character of the manuring, except with regard to potash.

7. Substantial changes in the power of the soil to supply plant food have taken place as a result of the manuring. The most marked effect is the removal of carbonate of lime by the prolonged use of ammonium salts.

8. The effects—direct and indirect—of the manuring upon the soil have led to marked differences in bacterial activity. In some cases the reduction in biological activity is so great that dead grasses accumulate and form a mat on the soil so thick that the penetration of water to the lower layers is seriously impeded.

Improvement of Upland Grazings (*Paper read at Brit. Assoc.*, 1915; *D. Macpherson, B.Sc., and W. G. Smith, B.Sc., Ph.D.*).—The upland grazings in Scotland comprise 48 per cent. of the total land area of the country; they are mainly devoted to sheep-farming with the Blackface and Cheviot Mountain breeds; cattle grazing is confined to the lower marginal areas.

The dominant plants in the *peatlands* are heather, cotton grass and deer-hair grass, which provide valuable spring grazing. Retrogression

* A summary of reports on agricultural experiments and investigation is usually given in the *Journal*. The Board are anxious to obtain for inclusion copies of reports on inquiries, whether carried out by agricultural colleges, societies, or private persons.

of peat is widespread and little improvement is possible, draining increasing the proportion of heather but reducing that of cotton-grass and deer-hair grass, and favouring invasion of *Nardus*.

Nardus grassland occurs on wasting peat on steep slopes marginal to the moorland. It invades and is successive to the vegetation of the peatland; it is of secondary grazing value. Where flushing is possible good pasture may be induced; otherwise the grazing value is improved by burning on a short rotation.

Heatherlands form valuable grazing ground at all seasons. They are found on slopes where continuous leaching has impoverished the upper layers of the lighter soils, and where slow accumulation of humus occurs. The grazing value is greatly increased by regular burning on a suitable rotation; different burning rotations will be required according as the rejuvenating powers of the heatherland are slow or rapid.

Alluvial and Flush Grasslands provide the best pasturage on stream-side alluvials and on hill slopes flushed with water from springs; they may be used as wintering grounds or enclosed as meadows. The alluvia of the upper valleys are light and, accordingly, retrogression occurs through leaching where flushing is prevented. The lower valley alluvia tend to be heavier and their maintenance as grazing units depends on drainage. These grasslands can be made to replace heather and *Nardus* by suitable irrigation with water derived from springs or with surface water bearing rainwash. Invasion of acid water deteriorates the pastures, favours *Nardus*, and, where "pan" is formed, promotes retrogression to moorland. These grasslands are suitable subjects for manurial treatment (*e.g.*, basic slag). Destruction of bracken increases the productive capacity of the pasture.

LIVE STOCK, FEEDING STUFFS AND DAIRYING.

Cost of Food in the Production of Milk on Three Yorkshire Farms (*Paper read at the Brit. Assoc.*, 1915; *Prof. C. Crowther, M.A., Ph.D., and A. G. Ruston, B.A., B.Sc.*).—During the last four years investigations as to the cost of food in the production of milk have been carried out on a number of farms in the North and West Ridings of Yorkshire. In making the estimates the purchased feeding-stuffs have been taken at cost price, but for the home-grown feeding-stuffs the following arbitrary scale has been used (per ton): hay 55*s.*, oat straw 30*s.*, barley straw 25*s.*, mangolds 10*s.* 6*d.*, swedes 10*s.*, turnips 8*s.*, and 3*s.* 6*d.* per week for grazing for spring calves.

During the past year detailed records have been kept on three of the farms, which enable the *actual* costs of production of the home-grown feeding-stuffs on these farms to be arrived at. These were as follows:—

Costs of Production of Home-grown Foods.

Herd.	Grass.	Hay.	Straw.	Roots.
	Cost per Cow per Week.	Cost per Ton.	Cost per Ton.	Cost per Ton.
	s. *d.*	£ *s.* *d.*	*s.* *d.*	*s.* *d.*
A	2 0	1 13 0	10 6	5 8
B	1 7	1 8 9	15 2	7 7
C	1 9	1 11 0	14 6	8 5

The following table shows the results obtained by the two cost of production methods :—

Estimated Average Cost of Food per Gallon of Milk.

Herd.	Average Milk Yield per Head per Year.	"Arbitrary Scale."		"Cost Scale."	
		Total Cost of Food per Head per Year.	Average Cost of Food per Gallon of Milk.	Total Cost of Food per Head per Year.	Average Cost of Food per Gallon of Milk.
	Gallons.	£ s. d.	Pence.	£ s. d.	Pence.
A	677	14 0 6	4·97	9 11 6	3·39
B	656	13 17 5	5·08	9 13 9	3·54
C	672	14 13 6	5·24	10 10 4	3·76

Phosphorus Requirement of Lambs (*Jour. Agric. Research* [U.S.A.], August, 1915).—The results of these experiments indicated that the phosphorus requirement for the normal growth and fattening of lambs does not exceed 3 grammes per day per 100 lb. live-weight.

Hereditary Twinship in Sheep (*Jour. Agric. Research* [U.S.A.], September, 1915).—Data obtained from the American Shropshire Sheep Record are examined by statistical methods, and the conclusion is reached that, for the class of sheep considered, twin parents in general give a larger percentage of twins among offspring than do parents born as singles.

FORESTRY.

Effect of Grasses and Weeds round the Roots of Young Forest Trees (*Quart. Jour. Forestry*, July, 1915; *S. F. Armstrong and E. R. Pratt*).—Fourteen plots were laid out in 1912 on a rather sandy and porous soil on the Lower Greensand. On each plot were planted three young trees of ash and two of larch, the distance between each tree being 16 in. to 17 in. Round the young trees were planted or sown various grasses and weeds, two control plots being kept free from these.

At the close of the first season the most striking features were the unhealthy appearance of the buds and foliage of the trees on the grass-covered plots. In the second season the harmful effects were again observed in greater degree, and the difference between the trees on the control plots and the other plots as regards height and general vigour was very marked in all cases.

The following table shows the total increase per plot in height in the two seasons. It will be seen that the toxic effect of grass is greater than that of the two common weeds tried :—

	In.		Per cent.
Perennial Rye grass	21	....	13
Couch grass	24	....	15
Control	164	....	100
Smooth-stalked Meadow grass ..	49½	....	31
Wood False Brome grass	46	....	29
Stinging Nettle	65⅛	....	41
Yorkshire Fog	43½	....	27
Creeping Buttercup	83	....	52
Cocksfoot grass	36	....	23
False Oat grass	47½	....	30
Fiorin sown	29	....	18
Control	150½	....	100
Fiorin planted	51½	....	33
Giant Brome grass	48½	....	31

The shading power of the plants had little or nothing to do with the harmful effects observed; and it was clear that the grasses forming the densest covering with their rapid-growing fibrous roots produced the most serious toxic effects.

The relative effect of the different species upon the two kinds of trees was very similar, though on the whole the larch suffered more in the first year, and the ash more in the second.

Rest Period in Plants (*Missouri Univ. Agric. Expt. Sta., Research Bull.* 16).—Investigations carried out in 1905–6 with twigs of broad-leaved trees and shrubs established the fact that nearly all woody plants native to the temperate zone have a "rest period," *i.e.*, at the beginning of winter, if placed under favourable conditions for growth, the plants remain dormant. Doubts having been cast on the use of twigs in the investigations alluded to, further tests were commenced in 1907 with a collection of one to three year old seedlings in pots in order to obtain further details as to their dormant periods. The bulletin gives particulars of the normal dormant periods in the case of each of 42 species tested, together with the treatment applied to initiate growth, and the results obtained.

The tests with pot-plants confirmed those carried out with twigs, *viz.*, that all woody plants rest annually for a longer or a shorter period. It was found that the rest period could be broken and growth initiated by special treatment. In the autumn the plants were removed to the greenhouse without being exposed to frost. They were then either dried, frozen, or etherized for various periods, from 24 hours to 8 days, and in the majority of cases growth was initiated in the course of a few weeks after treatment. Ether was found to be by far the most efficient agent for the purpose, though in the case of the pot-plants the soil had to be dried or else carefully covered up to prevent the absorption of the ether by the soil. A few species, among which are *Fraxinus Ornus* and *Juglans nigra*, are very difficult to arouse into growth, but it is believed that the rest period can in all cases be broken by proper treatment.

It would appear that the explanation of the rest period is to be sought in the buds rather than in the roots or in the cambium of the trunk or branches. It is considered probable that plants become dormant because the enzymes or ferments cease to work, and that growth starts again when these ferments are activated.

An investigation is now being conducted for the purpose of studying the work and activities of the enzymes during the dormancy of woody plants as well as during growth.

OFFICIAL NOTICES AND CIRCULARS.

Foot-and-Mouth Disease in Somerset.

THE existence of foot-and-mouth disease amongst animals on the premises of the County Asylum, Wells, Somerset, has been confirmed to-day.

The usual precautions have been taken to prevent the spread of the disease, and an Order has been made prohibiting the movement of animals in a large area surrounding the infected farm.

Women's Work on the Land.

THE Board of Trade, in consultation with the Board of Agriculture, are taking active steps to mobilise a sufficient supply of women for work on the land in order to meet the shortage of agricultural labour due to the enlistment of men in His Majesty's forces. The reserves of women's labour available for agriculture are to be found chiefly among the local unoccupied women in country villages who have some experience of or familiarity with agricultural work, and also among the better educated women who are willing to be trained for this purpose.

A scheme has already been adopted in many counties which is producing satisfactory results. Women's county committees, working either in co-operation with, or as sub-committees of the War Agricultural Committees, have already been established in twenty-five counties; in the other counties it is hoped that similar committees of women will shortly be formed. A scheme of systematic propaganda work is being carried on in all parts of the country by means of local meetings, followed by house to house canvass. Village registers are being established, and women urged on patriotic grounds to enrol for farm work for whole or part time. In order to press forward with this work, the Board of Agriculture is forming a panel of speakers who will be available to address meetings, and additional women organisers have been appointed by the Board of Trade and allocated to various parts of the country.

Purchase of Sulphate of Ammonia by Farmers.

IN view of the uncertainty as to the sufficiency of the supplies of sulphate of ammonia to meet the home demands during the next few months it has been decided, on the recommendation of the Fertilisers Committee, with the approval of the President of the Board of Agriculture and Fisheries and the President of the Board of Trade, to suspend for the present the issue of licences for the export of sulphate of ammonia. Under normal conditions it is well known that the production of sulphate of ammonia considerably exceeds home requirements, but Lord Selborne confidently hopes that farmers will this year greatly increase their demands for fertilisers of all descriptions so as to stimulate, so far as practicable, the production from the land, and thus reduce the importation of foodstuffs. This stimulus is the more necessary to counterbalance, in some degree, the hindrances to production arising from shortage of labour and other causes. Lord Selborne, therefore, appeals to farmers generally to justify his belief in their enterprise and patriotism by availing themselves of the opportunity now provided to secure plentiful supplies of fertilisers.

Farmers are especially urged to place their orders for sulphate of ammonia at once so as to enable the expected increased demand to be met without undue delay or difficulty.

Sulphate of Ammonia: Need for Increased Purchase by Farmers.

LORD SELBORNE desires to call the attention of farmers to the fact that the decision to suspend the issue of licences for the export of sulphate of ammonia was based on the assumption that the home demand for this fertiliser would be substantially increased. Unless, therefore, farmers at once increase their demand, the result will be that stocks will accumulate and the output will be cur-

tailed. In view of the importance of using every effort to stimulate the production of maximum crops during the war, in the interests both of agriculture and of the nation generally, Lord Selborne appeals to farmers to avail themselves, without delay, of the present opportunity to procure supplies of sulphate of ammonia for spring use.

Leaflets dealing with the use of sulphate of ammonia may be obtained, free of charge, on application to the Secretary, Board of Agriculture and Fisheries, Whitehall Place, London, S.W.

Notice to Farmers: Military Service Act, 1916.

1. **To whom the Law applies.**—The Act applies to all British subjects who :—

(1) Were ordinarily resident in Great Britain on the 15th August, 1915, or have become or hereafter become ordinarily resident in Great Britain since that date.

(2) Had attained the age of 18 years on the 15th August, 1915, and had not attained the age of 41 before the "appointed date" (2nd March, 1916).

(3) Were, on the 2nd November, 1915, single or were widowers without children dependent on them, subject to certain exceptions amongst which are :—

(*a*) Members of His Majesty's Regular or Reserve Forces.

(*b*) Men who have left or been discharged from the naval or military service of the Crown in consequence of disablement or ill health.

(*c*) Men who have offered themselves for enlistment and have been rejected since the 14th day of August, 1915.

It does not apply to Attested Men.—The Act does not apply to men who voluntarily attested under the Group System (commonly known as Lord Derby's Scheme) in Section B. Army Reserve, and who are entitled to wear an armlet as being soldiers in the Reserve.

2. **Persons deemed to have been Enlisted.**—Every man to whom the Act applies, and who is not included in the list of exceptions, will on the appointed date (2nd March, 1916) be deemed to have been enlisted, and to have been passed to the Reserve.

It is the intention of the Army Council that the men shall be placed, and be called up in age classes as in the case of men voluntarily attested.

3. **Who may be Exempted: Certified Occupations.**—Under Section 2 (2) of the Act, Government Departments are empowered to certify that men engaged in certain occupations (known as "certified occupations") may be exempted on the ground that the work of such men is work of national importance; and the *Agricultural Occupations* which have been so certified by the Board of Agriculture and Fisheries are as follows :—

Agricultural Engine-men and Mechanics. Agricultural Machinery, Steam Ploughs, and Threshing Machines Attendant, Driver, Mechanic.

Farm Workers.—Farm Bailiff, Foreman, Grieve, Steward.

,, Beastman, Byreman, Cattleman, Stockman, Yardman.

,, Carter, Horseman, Ploughman, Teamster, Waggoner.

,, Hind (if foreman or ploughman).

,, Servant (if foreman or ploughman) (Scotland).

,, Shepherd.

Thatcher.

Farmers and Market Gardeners.—Farmer (including market gardener and fruit farmer) provided that :—

(*a*) Farming is his sole occupation, and his personal labour or superintendence is indispensable for the proper cultivation of his holding ; or,

(*b*) If he is partly occupied in another occupation, and his personal labour or superintendence is indispensable for the proper cultivation of his holding, and such cultivation is expedient in the national interest.

Hop, Fruit and Market Gardens. Foreman in all departments.

Stud Attendants.—Stallion man (a man who looks after and travels a stallion). Stud Groom (Scotland).

It will be seen that these "certified occupations" are the same as those hitherto known as "starred" or "reserved" occupations, with some additions and revisions, notably that of "*Farmer* (including *Market Gardener and Fruit Farmer*)."

"*Occupation*" *Claimed must be Genuine.*—The only persons entitled to be exempted on account of being employed in the "certified occupations" are those whose principal and usual occupation is one of those included in the above list. By the use of the term "principal and usual occupation" it is intended to exclude from exemption those persons who may be only occasionally employed in work of a kind similar to that of one of the occupations, but who do not follow it in any regular fashion, and are not really engaged in the occupation in the proper sense of the word.

4. **Men in Certified Occupations must apply for Certificates of Exemption.**—Application must be made for a certificate of exemption in the case of every man in one of the "certified occupations" *who has not attested, and who desires to be exempted from the provisions of the Act.* The fact that he may have already been "starred" or included in the list of "reserved occupations" makes no difference in this respect.

5. **Application to be made to the Local Tribunal.**—Applications for exemption must be made to the Local Tribunal for the area in which the place of the applicant's employment is situated.

6. **Apply before 2nd March, 1916.**—Applications for exemption must be made before the appointed date, which is the 2nd March, 1916, and may be made either by the man himself who desires exemption, or by some person, his employer, for example, in respect of him. It will be an advantage that in the case of an employed person, a signed statement should be furnished from the employer giving full particulars of the man's occupation.

7. **Forms of Application must be obtained.** — Applications for exemption must be made *in duplicate* on the prescribed form which may be obtained from the Clerk of the Local Tribunal.

8. **How to obtain and send in Forms.**—Applications for forms and forms of application when filled up must be addressed to the Office of the Clerk of the Local Tribunal, and may be delivered at or sent by post to that Office.

9. **Exemptions Granted to Men in Certified Occupations unless Objected to.**—A certificate of personal exemption must be granted by the Local Tribunal to any man who shows that his principal and usual occupation is one of those in the list of "certified occupations" (see para. 3 above) *unless an objection has been received from the military representative.*

10. **Grounds on which Exemptions may be Objected to.**—The military

representative may object to a certificate of exemption being granted on the grounds that :—

(*a*) The man's principal and usual occupation is not in fact one of the "certified occupations," or that

(*b*) Notwithstanding that the man's principal and usual occupation is one of the "certified occupations" it is no longer necessary in the national interest that he should continue in civil employment.

11. **Exemption may be "Absolute" or "Conditional" or "Temporary."**—A certificate of exemption in respect of a man in a "certified occupation" will generally be absolute. A certificate will be conditional or temporary only if there are special reasons for this course. All certificates will be open to review on the application of the holder of the certificate or of the military authorities.

12. **Claims for Exemption in Occupations other than Certified Occupations.**—An application for a certificate of exemption may also be made by or in respect of a man who is not engaged in a "certified occupation," on any of the following grounds :—

(*a*) On the ground that it is expedient in the national interest that the man should, instead of being employed in military service, be engaged in other work in which he is habitually engaged.

(*b*) On the ground that it is expedient in the national interest that the man should, instead of being employed in military service, be engaged in other work in which he wishes to be engaged.

(*c*) If the man is being educated or trained for any work, on the ground that it is expedient in the national interests, that instead of being employed in military service, he should continue to be so educated or trained.

(*d*) On the ground that serious hardship would ensue if the man were called up for Army service owing to his exceptional financial or business obligations or domestic position

(*e*) On the ground of ill health or infirmity.

(*f*) On the ground of a conscientious objection to the undertaking of combatant service.

and the Local Tribunal, if they consider the grounds of the application established, and the military representative assents to the application, shall issue such a certificate to the man in respect of whom the application is made. A certificate of exemption may be absolute, conditional, or temporary, as the Local Tribunal think best suited to the case.

13. **Appeals from decisions of Local Tribunals must be made within 3 days.**—Appeal Tribunals will be established to which an appeal may be made by any person dissatisfied with the decision of the Local Tribunal or by the military authorities. The appeal must be made not later than three clear days after the decision of the Local Tribunal, and proper forms for the purpose may be obtained from the Clerk to the Local Tribunal. Further appeal may be made by leave of the Appeal Tribunal from that Tribunal to the Central Tribunal, but it is not intended that cases shall come before the Central Tribunal unless important questions of principle are involved, or unless there is some other special reason why an appeal should be allowed.

14. **Applicants for Exemption not to be called up pending decision on Application.**—A man who has made an application for exemption within the time fixed (*i.e.*, before 2nd March, 1916) will not be called up until his application has been finally disposed of, and, if granted a

certificate will be exempted according to the terms of that certificate from the provisions of the Act.

15. **Duration and Renewal of Exemption.**—A man who holds a certificate of exemption will not be deemed to have been enlisted while his certificate is in force, and if it ceases to be in force he is allowed a period of two months in which, if he is entitled to be exempted, he can obtain a renewal of the certificate.

16. **Cases of Men who have applied to be treated as "Starred."**—In a number of cases, application has already been made under the old arrangement, to the existing Local Tribunals, that a man is entitled to be treated as a "starred" man because he is engaged in a "starred" occupation, but has not in fact been "starred."

It has been provided as regards these cases that if a decision has been given by the Central Appeal Tribunal, that the man is to be entitled to be treated as "starred," the letter conveying the decision of the Central Appeal Tribunal is to be accepted as conclusive by the Local Tribunal, that the principal and usual occupation of the man is one of those in the list of "certified occupations," and that, so far as his occupation goes, he is, therefore, entitled to a certificate of exemption. The case will be open to review in the same manner as the cases of other men holding certificates of exemption.

17. **Men who have attested under "Lord Derby's Scheme."**—The cases of men who have attested voluntarily under the "Derby Scheme" do not come within the provisions of the Act, but it is the intention that the two classes of cases, those of men who came under the Act, and those of men who have voluntarily attested, shall be dealt with on the same lines and the constitution of the existing Local Tribunals will be modified where necessary for this purpose.

New instructions will be issued by the Local Government Board for the observance of Local Tribunals in dealing with these cases, and such instructions will supersede those previously made.

Under the existing instructions, the Local Tribunals can grant only postponement under the new instructions, they will be able to grant exemption.

18. **No further applications to be treated as "Starred."**—Applications will not be entertained in future by Local Tribunals that a man is entitled to be treated as "starred." It is proposed to provide that a voluntarily attested man whose principal and usual occupation is one of those included in the list of "certified occupations" may go to the *local military representative* and claim that he is engaged in one of these occupations, and, therefore, should not be called up for military service. If the military representative agrees to the claim the necessary steps will be taken by the military authorities to secure that the man is not called up so long as the exemption continues, and the matter will not come before the Local Tribunal. If the military representative disagrees application may be made by or in respect of the man to the Local Tribunal, who will decide the case in accordance with the Instructions.

Notice to Farmers as to Soldier Labour.

THE Board of Agriculture and Fisheries desire to bring to the notice of farmers in England and Wales the arrangements which, in view of the shortage of agricultural labour, have been made by the Army Council for the employment of soldiers on farm work at any season of the year (except during the corn harvest).

Employers of Soldiers as distinct from Convalescents.

1. Furlough will be given at the discretion of the Military Authorities, and as circumstances may permit, to a limited number of soldiers serving at home who have been accustomed to work on farms.

2. The furlough granted to each soldier will last only for such number of days, not exceeding 4 weeks, as he is actually required for the work.

The employment of soldiers will be subject to the following conditions:—

(*a*) That suitable labour cannot be obtained in the locality,

(*b*) That the farmer will undertake to pay each soldier sent at his request:—

(i.) 4*s.* a day if the soldier provides his own board and lodging.

(ii.) 2*s.* 6*d.* a day if board and lodging is provided by the farmer.

The hours worked to be those customary in the district.

(*c*) That the farmer will provide conveyance from and to the nearest railway station.

The above rates to be inclusive of all allowances, and to be paid, wet or fine.

No charge will be made to the farmer for railway travelling expenses.

3. Application may be made for men for any class of farm work, and the nature of the work should be specified on the form of application, to enable the Commanding Officer to select a suitable man so far as is possible.

4. Every endeavour will be made to ensure that the men released have been accustomed to the farm work indicated in the application, but no guarantee to this effect can be given, and if a farmer wants his son, or one of his former labourers who is serving at home, efforts will be made to arrange accordingly.

5. Applications from farmers who desire to employ soldiers must be made as soon as possible to the Board of Trade Labour Exchanges, when the application will be transmitted to the Military Authorities. Forms for the purpose will be supplied by the Local Labour Exchange, the address of which can be obtained from the nearest Post Office.

6. In the case of a farmer living in the neighbourhood of a military station, he may apply direct to a Commanding Officer for military labour which he requires at short notice, and for a period not exceeding 6 working days. This arrangement may enable the farmer to take advantage of fine days or short intervals of fine weather suitable for his work.

7. The above arrangements do not apply to the release of soldiers for the corn harvest, as to which a further notice will be issued in due course.

Employment of Convalescent Soldiers.

8. The Army Council have arranged that convalescents at Infantry Depots, Command Depots and Convalescent Hospitals, may be employed temporarily on agricultural work within easy reach of where they are stationed.

9. Applications from farmers who desire to employ such soldiers should be made as indicated in paragraph 5 above, but in the case of a farmer living in the neighbourhood of the man's military station requiring a man at short notice, the farmer may apply direct to the Officer Commanding the depot or hospital.

10. In making application, the farmer must state clearly the exact nature of the employment in order that the Military Authorities may be in a position to decide whether a soldier is capable of undertaking the work he would be called upon to do.

11. For the purpose of such employment, soldiers will be granted sick furlough, which will be liable to be cancelled forthwith, if at any time a man's health so improves that he is fit for discharge from the depot or hospital, or if his health is suffering from the work.

12. The soldier may either live away from the depot or hospital, or go to his work daily from his military quarters.

13. The cost, if any, of moving the man to or from his work must be borne by the farmer, except that no charge will be made to the farmer for railway travelling expenses, if the man is to be employed for a week or more at a distance of 20 miles, or over, by rail, or if the man is to be away at least 3 days at a distance by rail of less than 20 miles.

14. The employment will be subject to the following conditions:—

(*a*) That suitable labour cannot be obtained in the locality.

(*b*) That if the soldier goes away from his military station, the farmer will undertake to pay each soldier sent at his request:—

(i.) 3*s.* 6*d.* a day if the soldier provides his own board and lodging.

(ii.) 2*s.* a day if board and lodging is provided by the farmer.

The hours worked to be those customary in the district.

(*c*) That one rest day must be allowed by the farmer in every seven days, for which the soldier will receive Army pay.

(*d*) That if the soldier goes and returns each day to his depot or hospital, the farmer will undertake to pay the soldier at the rate of 3*d.* per hour, including hours for meals. In such a case at least one good meal must be provided by the farmer, if the hours of work are such as to prevent the soldier returning to his unit for his midday meal. The payment referred to will be made weekly by the farmer to the Officer Commanding the depot or hospital.

(*e*) That the farmer will provide conveyance from and to the nearest railway station.

15. The above rates of pay will be inclusive of all allowances except as regards the midday meal referred to, and must be paid, wet or fine.

The following circular, dated 22nd January, 1916, has been addressed by the Board to the Secretaries of the County War Agricultural Committees:—

Increased Production of Food during the War.

SIR,—1. Lord Selborne has received many suggestions from Lord Milner's Committee and other sources, of methods by which the production of food in this country during the war can be maintained and increased. He is well aware that these suggestions have probably already been considered by your Committee, but he thinks it due to the willing help of those from whom they emanate that he should circulate them. They are obviously unequal in importance, but their aggregate value is considerable.

2. Lord Milner's Committee expressed the hope that the consent of landowners to the breaking up of grass land for the purpose of growing

wheat or making more room for wheat on arable land should not be withheld, notwithstanding the existence of restrictive covenants in leases. If any cases come to your Committee's notice of such consent being unreasonably withheld perhaps they may find means to bring the recommendation of the Departmental Committee to the notice of the landowner concerned, and to use their good offices to obtain his consent to the waiving of restrictions which may have been framed in normal times to meet normal conditions.

3. The making and planting of osier beds under suitable conditions is often a profitable undertaking, and can be done on land of but little use for other purposes. In circumstances of this kind your Committee might appeal to landowners, where necessary, not to refuse the consent which is required under the Agricultural Holdings Act, 1908, to establish the tenant's right on quitting, to claim compensation, and which is an essential preliminary to justify a tenant undertaking the trouble and expense involved in producing osiers for the basket-making industry of this country. It is really important that as many baskets as possible should be produced at home, and as few as possible imported.

4. Lord Milner's Committee recommended also that owners should consider the use being made of their moorlands, with the object of ensuring that they are stocked with as many sheep as the land can carry. The Committee accompanied their recommendation with an expression of opinion that owing to the differences in local conditions no general rule could be laid down as to the proportion which should exist between the number of sheep and the acreage of moorland, but they expressed the belief that not infrequently permission might safely be given, as a temporary measure, to pasture more sheep than are normally kept on moors without any harm resulting.

5. The Committee also recommended that parks and golf courses should be used to their maximum capacity for grazing stock.

6. Attention has been drawn to the opportunities which local authorities, land owners, and other residents may possess of helping farmers by releasing as many of their employees as possible for work on the land. This has certainly been done in very many instances, but the value to the farmer of the occasional assistance of game keepers, woodmen, roadmen, garden labourers, and men of that class, most of whom possess some practical knowledge of farm work, can hardly be over-estimated at a time when the shortage of skilled farm hands is necessarily so acute.

7. From reports which Lord Selborne has received from different parts of the country it would seem that in some cases farmers are prevented from using their land in the manner most profitable to the community by damage or the fear of damage by game and rabbits.

8. For various reasons pheasant rearing was, to a great extent, abandoned or restricted last season, and next season this may be found to be even more generally the case, but if any instance should be brought to the notice of your Committee of pheasant rearing on any considerable scale, Lord Selborne hopes that your Committee will appeal in his name to the landowner or shooting tenant to subordinate his personal interests to those of the community, which clearly require at the present time the production at home of as great a supply of food as the land can be made to produce.

9. Lord Selborne realises that it is difficult for landowners or tenants at the present time to provide the labour necessary for keeping down

the stock of rabbits, but he trusts that your Committee will do all they can to promote co-operation between the landowner and the tenant in dealing with this matter with a view to effecting the maximum destruction of rabbits with the minimum of labour.

10. I am, further, to suggest that your Committee should bring to the notice of the Urban District Councils in your County the possibility of utilising spare building and other vacant plots for the purpose of growing vegetables and similar crops.

11. I am to enclose, for the information of your Committee, two copies of a letter [not printed], which Lord Selborne has addressed to the Mayors of County Boroughs and Boroughs in England and Wales with regard to the provision and cultivation of allotments.

12. I am also to enclose 50 copies of a list of leaflets issued by the Board, and I am to suggest that you should send a copy to the Secretaries of each of the District Committees set up in your County, for their information.

I am, &c.,

SYDNEY OLIVIER, *Secretary*.

Spread of Disease from Army to Agricultural Horses.

REPRESENTATIONS have been made to the Board of Agriculture and Fisheries that a number of cases of disease amongst agricultural horses have been due to contact with military horses, or to the presence of such horses in the locality.

While the conditions prevailing in war render it almost impossible to prevent isolated cases occurring in which disease is so spread, it cannot be overlooked that even in normal times equine diseases are by no means infrequent in this country.

The Army Council have issued instructions that the utmost care is to be taken to obviate possible injury to agricultural and other horses by the presence of infected military horses, but absolute immunity from such injury cannot be effected unless agricultural and other horse owners themselves render assistance.

The President of the Board of Agriculture and Fisheries therefore desires to impress on agriculturists the great importance of taking all possible steps to prevent the spread of disease and to co-operate with the military authorities as closely as possible to achieve this object.

Committee on the Settlement and Employment on the Land of Discharged Sailors and Soldiers.

THE President of the Board of Agriculture and Fisheries has appointed the Right Hon. Henry Hobhouse to be Chairman of the Departmental Committee on the Settlement and Employment on the land of Discharged Sailors and Soldiers, in the place of Sir Harry Verney, Bart., M.P., who has received a Commission in the Army; and he has appointed the Hon. E. G. Strutt, and Sir Luke White, M.P., to be additional members of the Committee; Mr. H. L. French, of the Board of Agriculture and Fisheries, has been appointed Secretary to the Committee.

The Committee, which was appointed by Lord Selborne in July last, have presented the First Part of their Report dealing with Settlement, a summary of which will be found on p. 1166. They are now considering the Second Part, which will deal with Employment.

Acreage and Production of Crops.

Crops.	Acreage. 1915.	Acreage. 1914.	Produce.** 1915.	Produce.** 1914.	Yield per acre. 1915.	Yield per acre. 1914.	Average yield per acre of 10 years, 1905-14.
Total Area (excluding water)	Acres. 76,455,346.						
Total Acreage of Crops and Grass†	46,554,185	46,642,957	—	—	—	—	—
Arable Land	19,254,512	19,320,823	—	—	—	—	—
Permanent Grass—			Tons.	Tons.	Cwt.	Cwt.	Cwt.
For Hay	6,393,365	6,489,885	7,922,591	8,192,555	24·78	25·25	28·27
Not for Hay	20,906,308	20,832,243	—	—	—	—	—
Total	27,299,673	27,322,128	—	—	—	—	—
			Quarters.	Quarters.	Bush.	Bush.	Bush.
Wheat	2,333,354	1,904,932	9,239,355	7,804,041	31·68	32·77	32·35
Barley or Bere	1,522,654	1,871,169	5,862,244	8,065,078	30·80	34·48	34·38
Oats	4,159,312	3,877,964	22,308,395	20,663,537	42·91	42·63	42·12
Rye	59,934	66,783	—	—	—	—	—
‡Beans	272,929	301,375	924,155	1,120,078	28·00	30·72	30·52
‡Peas	130,226	169,804	300,338	374,038	24·38	23·02	26·39
			Tons.	Tons.	Tons.	Tons.	Tons.
Potatoes	1,202,259	1,197,008	7,540,240	7,476,458	6·27	6·25	5·73
Turnips and Swedes	1,617,973	1,752,574	24,131,083	24,193,755	15·13	13·83	14·56
Mangold	498,934	515,864	9,696,499	9,522,921	19·48	18·50	19·41
Cabbage, Koh-rabi and Rape	183,844	191,343	—	—	—	—	—
§Vetches or Tares	123,589	137,447	—	—	—	—	—
			Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Hops	34,744	36,661	254,609	507,238	7·33	13·84	9·73
¶Small Fruit	97 126	100,719	—	—	—	—	—
Clover and Rotation Grasses—			Tons.	Tons.			
For Hay	2,837,030	2,902,902	4,526,192	4,210,924	31·91	29·01	32·05
Not for Hay	3,583,943	3,659,688	—	—	—	—	—
Total	6,420,973	6,562,590	—	—	—	—	—
Other Crops	280,228	286,625	—	—	—	—	—
Bare Fallow	316,613	347 965	—	—	—	—	—

Live Stock.

	1915.	1914.
Horses used for Agricultural Purposes (including Mares kept for breeding)	No. 1,217,880	No 1,320,466
Unbroken Horses, including Stallions { One year and above	319,159	350,362
Unbroken Horses, including Stallions { Under one year	166,581	171,729
Total Horses	1,703,620	1,842,557
Cows and Heifers in Milk or in Calf	4,476,788	4,576,852
Other Cattle { Two years and above	2,218,246	2,326,591
Other Cattle { One year and under two	2,050,053	2,587,853
Other Cattle { Under one year	2,780,795	2,653,271
Total Cattle	12,131,882	12,144,563
Ewes kept for breeding	11,308,451	11,221,604
Other Sheep { One year and above	5,390,746	5,037,911
Other Sheep { Under one year	11,499 245	11,626,580
Total Sheep	28,198,442	27,886,095
Sows kept for breeding	437,828	492,981
Other Pigs	3,346,505	3,446,906
Total Pigs	3,784,333	3,939,887

* Exclusive of the Isle of Man and Channel Islands, where no produce statistics are collected.
** The figures of Produce for Ireland are subject to revision.
† Exclusive of Mountain and Heath land used for grazing.
‡ Figures include acreage, but not produce of areas picked or cut green, except in the case of beans in Scotland, where the acreage picked or cut green is excluded.
§ Figures for Scotland include beans, mashlum, etc., for fodder.
¶ Figures for Ireland include orchards.

MISCELLANEOUS NOTES.

Notes on Crop Prospects and Live Stock Abroad.

THE *Bulletin of Agricultural and Commercial Statistics* for January, 1916, issued by the International Institute of Agriculture, shows the production of cereal crops during the past year. The countries for which it is possible to give an approximate estimate are as follows:—In *Europe*—Hungary (proper), Bulgaria, Denmark, Spain, France, Great Britain, Ireland, Italy, Luxemburg, Norway, Netherlands, Rumania, Russia in Europe (54 governments), Switzerland; in *America*—Canada, United States; in *Asia*—India, Japan, Russia in Asia (10 governments in 1915 and 9 governments in 1914); in *Africa*—Egypt, Tunis,

Wheat.—In the above countries the production is estimated to amount to 460,047,000 qr. in 1915, against 374,959,000 qr. in 1914, or an increase of 22·7 per cent. By the addition of the production for Argentina and Australia a figure is obtained which may be taken to approximately represent the world's production of wheat, viz.:—500,931,000 qr. in 1915-16, against 399,117,000 qr. in 1914-15, an increase of 25·5 per cent.

Rye.—The total production in the aforementioned countries, excluding Great Britain, India, Japan, Egypt, and Tunis, is estimated at 138,568,000 qr. in 1915, compared with 120,208,000 qr. in 1914, an increase of 15·3 per cent.

Barley.—The production in the specified countries, with the exception of India, is estimated to approximate to 148,323,000 qr. in 1915, against 126,345,000 qr. in 1914, an increase of 17·4 per cent.

Oats.—The total production in the above countries, excluding India, Japan, and Egypt, is placed at 404,726,000 qr. in 1915, against 322,300,000 qr. in 1914, an increase of 25·6 per cent. The combined total for these countries and Argentina, which may be taken to approximate to the world's production, amounted to 411,953,000 qr. in 1915-16, against 328,171,000 qr. in 1914-15, an increase of 25·5 per cent.

Maize.—In Hungary, Italy, Rumania, Russia in Europe (54 Governments), Switzerland, Canada, United States, Japan, and Russia in Asia (10 governments in 1915 and 9 governments in 1914), the total production is estimated at 413,489,000 qr. in 1915, against 368,397,000 qr. in 1914, an increase of 12·2 per cent.

France.—According to the preliminary official report the areas sown with winter grain up to the 1st January were as follows:—Wheat, 12,400,000 acres as compared with 13,600,000 acres in the previous year; rye, 2,300,000 acres against 2,600,000 acres; oats, 1,700,000 acres against 1,900,000 acres; and barley, 250,000 acres against 370,000 acres. The condition of wheat on the 1st January was 69, rye 68, barley 71, and oats 71 (100 = very good, 80 = good, 60 = fairly good).—(*The London Grain, Seed and Oil Reporter*, 24th January.)

Russia.—According to an official report the condition of the autumn-sown crops of rye, wheat and barley, on the 29th November, was extremely favourable. In only one (Ural) of the 62 governments and provinces from which reports were received, were the crops considered below average, whilst 6 per cent. of the governments reported satisfactory, and 92 per cent. above average crops.—(*Broomhall's Corn Trade News*, 12th January.)

Canada.—According to the final returns of the Census and Statistics Office, the total production of wheat in Canada last year was 376,303,600

bush. as compared with 161,280,000 bush. in 1914; oats, 520,103,000 bush. against 313,078,000 bush.; barley, 53,331,300 bush. against 36,201,000 bush.; linseed, 10,628,000 bush. against 7,175,200 bush.; and maize, 14,368,000 bush., against 13,924,000 bush. in 1914.

India.—The first Government forecast of the area under wheat, based on reports received from all the important wheat-growing areas, except Indore and Bhopal, and six states of comparatively small importance in Rajputana, states that the area sown up to the end of November last was 27,604,000 acres as compared with 28,852,000 acres last year, or a decrease of 4 per cent. The sowing season has, on the whole, been quite favourable, except in the western and south-eastern Punjab, the western districts of the United Provinces, in Gujarat, Sind, and in parts of the North-West Frontier Province and Rajputana. In these districts the rainfall was deficient. The condition and prospects of the crop are reported to be, on the whole, from fair to good, but rain was urgently required in the Punjab and in the western districts of the United Provinces at the date of the reports. The rain which fell in parts of these districts on the 15th December must, however, have benefited the crop.

Argentina.—According to the first official forecast the production of wheat is estimated at 23,013,000 qr. as compared with 21,053,000 qr. in 1914-15; oats, 7,735,000 qr. against 5,870,000 qr.; and linseed, 5,420,000 qr. against 5,963,000 qr. last year. (*Bulletin of Agricultural and Commercial Statistics*, January, 1916.)

The weather during the last week of December and first fortnight of January was fine and warm, and very favourable for harvesting and threshing operations. The hot sun and hot winds of the second week of January did some damage to the ripening maize, particularly in the provinces of Cordoba and Santa Fe, where the effects of the drought are beginning to cause some justifiable alarm. Damage by locusts is also being felt in these provinces and in Entre Rios, and there is reason to fear that an appreciable proportion of the maize crop has been lost in some districts of the province of Cordoba as a result of the drought and locusts. It is still hoped, however, that the final general results for this crop will be satisfactory. (*The Review of River Plate*, 14th January.)

Live Stock in United States—The Crop Reporting Board of the United States Department of Agriculture estimates that the number of horses in that country, on the 1st January, was 21,166,000, as compared with 21,195,000 on the 1st January, 1915; milch cows, 21,988,000 against 21,262,000; other cattle, 39,453,000 against 37,067,000; sheep, 49,162,000 against 49,956,000; and pigs, 68,047,000 against 64,618,000 a year ago.

Live Stock in New Zealand.—The Annual Sheep Returns for New Zealand for the year ended 30th April, 1915, show a total of 24,901,421 sheep, against 24,798,763 in 1914, or an increase of 0·4 per cent. (*Bulletin of Agricultural and Commercial Statistics, Jan.,* 1916.)

Agricultural Conditions in England and Wales on 1st February.

THE Crop Reporters of the Board, in reporting on the agricultural position on 1st February, state that January generally proved mild and open, and enabled good progress to be made in cultivating the ground; much of the arrears caused by the wet December being thus overtaken, while some more wheat was put in. In Wales and the north-west, however, the weather was more stormy, and work was greatly hindered. The

early sown wheat is looking very well everywhere; while the late sown, although still weaker and more backward than the first sowings, has greatly benefited by the mild weather, and is generally much more satisfactory than a month ago. Other autumn-sown crops are also healthy and satisfactory generally, though some are still backward.

There seems to be no scarcity of locally grown seed-potatoes, but those growers who usually obtain their seed from Scotland or Ireland are placing their orders early for fear of possible delays on the railway, and it would be advisable for others who get their seed from a distance to order in good time.

In the north ewes, owing to the long period of wet weather, are not considered to be up to the average in condition; but elsewhere they are stronger, and lambing prospects are reported on favourably. The Dorset Horn flocks have finished lambing, with a satisfactory fall, and progress among the early Down flocks in the south is also generally good, except perhaps in the Isle of Wight.

Live stock generally have done quite well during the month, many having been turned out into the open, which has enabled farmers to husband their supplies of roots and hay. These are, in many districts, somewhat short, but the mild weather has been of great benefit, and unless a prolonged cold spell sets in there should be about sufficient for requirements during the remainder of the winter.

Agricultural Labour in England and Wales during January.

ACCORDING to statements in the Board's *Monthly Agricultural Report* for 1st February, the supply of labour was everywhere decidedly deficient, and much apprehension was felt as to the prospects of getting through the heavy work of the spring. The conditions in the different districts were as follows:—

Northumberland, Durham, Cumberland and Westmorland.—Farm workers were very scarce throughout the division. At the Candlemas hirings in Cumberland very few men were on offer, and wages were very high.

Lancashire and Cheshire.—Labour was very scarce, and the difficulty in this respect is likely to become greater shortly, when the demand increases.

Yorkshire.—The supply of labour was very deficient, and wages were being increased in some districts. Horsemen seemed to be very scarce in some parts of the county.

Shropshire and Stafford.—The supply of labour was very scarce and farmers were becoming anxious.

Derby, Nottingham, Leicester and Rutland.—The supply of labour was still deficient, and there was very little prospect of improvement.

Lincoln and Norfolk.—The supply of labour was very short throughout the division, and women were being employed in some districts.

Suffolk, Cambridge and Huntingdon.—There was a short supply of labour in all districts, and it was expected to be keenly felt when the heavy spring work begins.

Bedford, Northampton, and Warwick.—Labour was deficient, and wages had risen in one or two districts.

Buckingham, Oxford, and Berkshire.—Labour was very short, and fears were expressed that the shortage will become serious later, when farm work increases in the spring. Threshing, in particular, was

reported to be difficult to arrange for, but neighbouring farmers were trying to ease matters by assisting one another.

Worcester, Hereford, and Gloucester.—There was a very short supply of labour throughout the division, and wages tended to increase.

Cornwall, Devon, and Somerset.—The supply of labour was still short for every class of farm work.

Dorset, Wiltshire, and Hampshire.—With lambing going on and the land fit to work, the shortage in the supply of labour was increasingly felt, and farmers were experiencing difficulty in getting their work done in some districts. Throughout the division labourers were scarce.

Surrey, Kent and Sussex.—Generally speaking, the supply of labour was still deficient, especially as regards horsemen. It was anticipated that the shortage will be more seriously felt in the future.

Essex, Hertford and Middlesex.—The supply of labour was very short, and farmers anticipated great difficulty in getting the spring work done.

North Wales.—The supply of labour during January was about sufficient in some districts, but short in others

Mid Wales.—The supply of labour continued to decrease, and in most parts of the division was very deficient.

South Wales.—There is no change to record in the position this month. The shortage of labour was very pronounced, and no relief was obtained from the assistance of women.

Prevalence of Animal Diseases on the Continent.

The following statement shows that according to the information in the possession of the Board on 1st February, 1916, certain diseases of animals existed in the countries specified :—

Austria (*on the 12th Jan.*).
Foot-and-Mouth Disease, Glanders and Farcy, Swine Erysipelas, Swine Fever.

Denmark (*month of Dec.*).
Anthrax, Foot-and-Mouth Disease (275 outbreaks), Glanders and Farcy, Swine Erysipelas, Swine Fever

France (*for the period 2nd—15th Jan.*).
Anthrax, Blackleg, Foot-and-Mouth Disease, Glanders and Farcy, Pleuro-pneumonia, Rabies, Sheep-scab, Swine Erysipelas, Swine Fever.

Germany (*for the period 1st—15th Jan.*).
Foot-and-Mouth Disease, Glanders and Farcy, Swine Fever.

Holland (*month of Dec.*).
Anthrax, Foot-and-Mouth Disease (147 outbreaks), Foot-rot, Swine Erysipelas.

Hungary (*on the 12th Jan.*).
Foot-and-Mouth Disease, Glanders and Farcy, Sheep-pox, Swine Erysipelas, Swine Fever.

Italy (*for the period 3rd—9th Jan.*).
Anthrax, Foot-and-Mouth Disease (2,873 outbreaks), Glanders, and Farcy, Rabies, Sheep-scab, Swine Fever, Tuberculosis.

Norway (*month of Dec.*).
Anthrax, Blackleg, Swine Fever.

Rumania (*for the period 14th—21st Dec.*).
Anthrax, Blackleg, Foot-and-Mouth Disease, Glanders, Rabies. Sheep-pox, Sheep-scab, Swine Fever,

Russia (*month of Aug.*).

Anthrax, Foot-and-Mouth Disease (324,017 animals), Glanders and Farcy, Pleuro-pneumonia, Rabies, Sheep-pox, Swine Erysipelas, Swine Fever.

Spain (*month of Oct.*).

Anthrax, Blackleg, Dourine, Glanders, Pleuro-pneumonia, Rabies, Sheep-pox, Sheep-scab, Swine Erysipelas, Tuberculosis.

Sweden (*month of Dec.*).

Anthrax, Foot-and-Mouth Disease (6 outbreaks), Swine Erysipelas.

Switzerland (*for the period 1st—9th Jan.*).

Anthrax, Blackleg, Foot-and-Mouth Disease (28 "étables" entailing 654 animals, of which 6 "étables" were declared infected during the period), Glanders, Swine Fever.

No further returns have been received in respect of the following countries:—Belgium, Bulgaria, Montenegro, Serbia.

The Weather in England during January.

District.	Temperature.		Rainfall.				Bright Sunshine.	
	Daily Mean.	Diff. from Average.	Amount.		Diff. from Average.	No. of Days with Rain.	Daily Mean.	Diff. from Average.
	°A.*	°A.*	In.	Mm.†	Mm.†		Hours.	Hours
Week ending Jan. 8th:	200+							
England, N.E. ...	81·2	+5·0	0·18	5	− 6	3	1·8	+0·7
England, E.	81·4	+5·5	0·83	21	+10	5	1·2	−0·1
Midland Counties ...	81·4	+5·5	0·59	15	+ 1	5	1·4	+0·2
England, S.E.... ...	81·9	+5·0	0·57	15	+ 1	5	1·3	−0·1
England, N.W. ...	81·6	+4·7	0·91	23	+ 6	6	1·2	+0·2
England, S.W. ...	82·0	+4.0	1·17	30	+ 7	6	1·7	+0·2
English Channel ...	83·0	+5·1	0·34	9	−11	5	1·9	0·0
Week ending Jan. 15th:								
England, N.E.... ...	78·9	+2·5	0·15	4	− 8	2	1·5	+0·4
England, E.	78·6	+2·7	0·15	4	− 6	3	2·0	+0·6
Midland Counties ...	79·3	+3·3	0·10	3	− 9	3	1·4	+0·1
England, S.E.... ...	79·4	+2·5	0·11	3	−10	3	1·8	+0·3
England, N.W. ...	80·2	+2·9	0·32	8	− 8	5	0·6	−0·5
England, S.W. ...	80·7	+2·7	0·17	5	−15	3	0·5	−1·0
English Channel ...	81·7	+1·9	0·21	5	−13	3	1·2	−0·8
Week ending Jan. 22nd:								
England, N.E. ...	80·8	+4·0	0·21	6	− 4	4	2·0	+0·6
England, E.	81·0	+4·6	0·46	12	+ 3	4	1·4	−0·2
Midland Counties ...	80·8	+4·3	0·31	8	− 3	4	1·7	+0·3
England, S.E.... ...	81·2	+3·9	0·52	13	+ 1	6	1·0	−0·6
England, N.W. ...	81·2	+3·8	0·95	24	+ 7	5	1·7	+0·5
England, S.W. ...	81·4	+3·1	0·85	22	+ 2	6	1·7	+0·1
English Channel ...	82·4	+2·5	0·52	13	− 3	7	1·5	−0·5
Week ending Jan. 29th:								
England, N.E. ...	79·6	+2·5	0·13	3	− 6	1	1·7	0·0
England, E.	79·5	+2·7	0·05	1	− 9	1	2·4	+0·4
Midland Counties ...	79·8	+2·9	0·07	2	−11	2	1·8	+0·1
England, S.E.... ...	80·5	+2·9	0·06	2	−11	2	2·4	+0·6
England, N.W. ...	80·4	+2·8	0·46	12	− 7	4	1·2	−0·2
England, S.W. ...	80·7	+2·2	0·21	6	−16	3	1·9	+0·1
English Channel ...	81·7	+1·6	0·13	3	−14	4	2·4	+0·2

* 273° A. (Absolute) = 0° C. = 32° F.; increment of 1°A. = increment of $\frac{9}{5}$°F.

† 1 inch = 25·4 millimetres.

DISEASES OF ANIMALS ACTS, 1894 to 1914.

NUMBER OF OUTBREAKS, and of ANIMALS Attacked or Slaughtered.

GREAT BRITAIN.

(From the Returns of the Board of Agriculture and Fisheries.)

DISEASE.	JANUARY.	
	1916.	1915.
Anthrax:—		
Outbreaks	63	88
Animals attacked	65	100
Foot-and-Mouth Disease:—		
Outbreaks	—	—
Animals attacked	—	—
Glanders (including Farcy):—		
Outbreaks	6	3
Animals attacked	24	5
Parasitic Mange:—		
Outbreaks	490	†—
Animals attacked	1,338	†—
Sheep-Scab:—		
Outbreaks	97	79
Swine Fever:—		
Outbreaks	385	407
Swine Slaughtered as diseased or exposed to infection	1,244	1,782

* Figures for nine months only. † The Parasitic Mange Order of 1911 was suspended from 6th August, 1914, to 27th March, 1915, inclusive.

IRELAND.

(From the Returns of the Department of Agriculture and Technical Instruction for Ireland.)

DISEASE.	JANUARY.	
	1916.	1915.
Anthrax:—		
Outbreaks	1	—
Animals attacked	5	—
Foot-and-Mouth Disease:—		
Outbreaks	—	—
Animals attacked	—	—
Glanders (including Farcy):—		
Outbreaks	—	—
Animals attacked	—	—
Parasitic Mange:—		
Outbreaks	9	5
Sheep-Scab:—		
Outbreaks	85	69
Swine Fever:—		
Outbreaks	18	20
Swine Slaughtered as diseased or exposed to infection	37	99

PRICES OF AGRICULTURAL PRODUCE.

AVERAGE PRICES of LIVE STOCK in ENGLAND and WALES in January, 1916, and December, 1915.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	JANUARY.		DECEMBER.	
	First Quality.	Second Quality.	First Quality.	Second Quality.
FAT STOCK:—	per stone.*	per stone.*	per stone.*	per stone.*
Cattle:—	s. d.	s. d.	s. d.	s. d.
Polled Scots	11 4	11 1	11 4	10 10
Herefords	11 2	10 2	11 1	10 1
Shorthorns	11 3	10 4	11 0	9 11
Devons	11 5	10 3	11 2	9 11
Welsh Runts	11 0	10 5	10 8	9 11
	per lb.*	per lb.*	per lb.*	per lb.*
	d.	d.	d.	d.
Veal Calves	10	9	9¾	8½
Sheep:—				
Downs	11¾	10½	11	10
Longwools	11	10	10¼	9¼
Cheviots	11¾	10¾	11	10
Blackfaced	11½	10¼	10¾	9½
Welsh	10¼	9¼	10	9
Cross-breds	11½	10½	10¾	9¾
	per stone.*	per stone.*	per stone.*	per stone.*
Pigs:—	s. d.	s. d.	s. d.	s. d.
Bacon Pigs	10 7	9 11	10 6	9 10
Porkers	11 6	10 10	11 4	10 8
LEAN STOCK:—	per head.	per head.	per head.	per head.
Milking Cows:—	£ s.	£ s.	£ s.	£ s.
Shorthorns—In Milk ...	29 12	24 2	29 19	24 10
,, —Calvers ...	29 1	23 0	28 7	23 6
Other Breeds—In Milk ...	28 0	24 2	29 2	23 18
,, —Calvers ...	21 10	19 10	—	20 0
Calves for Rearing	2 15	2 2	2 15	2 2
Store Cattle:—				
Shorthorns—Yearlings ...	12 15	10 16	12 7	10 7
,, —Two-year-olds...	17 5	15 3	16 14	15 3
,, —Three-year-olds	22 14	19 7	23 0	19 5
Herefords —Two-year-olds...	19 0	15 7	19 1	15 14
Devons— ,,	18 4	16 0	17 17	16 7
Welsh Runts— ,,	17 7	—	16 15	15 14
Store Sheep:—				
Hoggs, Hoggets, Tegs, and Lambs—	s. d.	s. d.	s. d.	s. d.
Downs or Longwools ...	53 6	45 7	49 8	42 11
Store Pigs:—				
8 to 12 weeks old	25 8	18 9	24 2	18 2
12 to 16 weeks old	44 7	34 4	43 10	33 4

* Estimated carcass weight.

AVERAGE PRICES of DEAD MEAT at certain MARKETS in ENGLAND in January, 1916.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	Birmingham.	Leeds.	Liverpool.	London.	Manchester.
		per cwt.	per cwt.	per cwt.	per cwt.	per cwt.
		s. d.	s. d.	s. d.	s. d.	s. d.
BEEF:—						
English	1st	76 0	73 6	—	76 6	73 0
	2nd	71 0	69 6	—	72 0	70 6
Cow and Bull	1st	69 0	68 0	64 0	67 0	67 0
	2nd	63 0	63 0	59 0	62 6	62 6
Irish: Port Killed	1st	71 0	71 6	72 6	74 6	70 6
	2nd	70 0	69 6	67 6	69 6	66 0
Argentine Frozen—						
Hind Quarters	1st	71 6	—	70 0	—	70 0
Fore ,, ...	1st	63 0	—	—	—	—
Argentine Chilled—						
Hind Quarters	1st	84 6	78 0	82 6	81 6	82 6
Fore ,, ...	1st	60 6	55 0	61 0	60 6	61 6
Australian Frozen—						
Hind Quarters	1st	63 6	—	67 6	—	67 6
Fore ,, ...	1st	53 6	—	59 0	—	59 0
VEAL:—						
British	1st	—	—	—	105 0	—
	2nd	88 6	—	—	95 6	—
Foreign...	1st	—	—	—	109 6	—
MUTTON:—						
Scotch	1st	93 6	88 6	98 6	95 6	98 6
	2nd	86 6	84 0	92 0	89 0	94 0
English...	1st	92 0	93 6	—	87 6	93 6
	2nd	87 0	88 6	—	82 0	88 6
Irish: Port Killed	1st	89 0	—	90 6	84 6	88 6
	2nd	87 0	—	81 6	79 6	84 0
Argentine Frozen	1st	71 0	71 0	69 6	70 0	69 6
Australian ,, ...	1st	66 6	69 6	69 0	65 6	69 0
New Zealand ,, ...	1st	69 0	70 0	—	72 6	—
LAMB:—						
British	1st	—	—	—	—	—
	2nd	—	—	—	—	—
New Zealand	1st	76 6	74 0	76 6	75 0	76 6
Australian	1st	71 6	—	71 6	71 0	72 6
Argentine	1st	73 6	74 6	73 0	71 6	72 6
PORK:—						
British	1st	95 6	94 6	98 0	98 0	97 0
	2nd	88 6	90 6	88 6	88 6	91 0
Frozen	1st	71 6	76 0	75 0	74 0	74 6

AVERAGE PRICES of PROVISIONS, POTATOES, and HAY at certain MARKETS in ENGLAND in January, 1916.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	BRISTOL.		LIVERPOOL.		LONDON.	
	First Quality.	Second Quality.	First Quality.	Second Quality.	First Quality.	Second Quality.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
BUTTER:—	per 12 lb.	per 12 lb.	per 12 lb.	per 12 lb.	per 12 lb.	per 12 lb.
British	19 0	17 9	—	—	19 0	18 0
	per cwt.	per cwt.	per cwt.	per cwt.	per cwt.	per cwt.
Irish Creamery—Fresh	—	—	—	—	—	—
,, Factory	134 0	127 0	134 0	126 0	—	—
Danish...	—	—	160 6	157 6	158 6	154 0
French...	—	—	—	—	164 0	158 0
Russian	130 0	122 0	—	124 0	131 0	123 6
Canadian...	150 0	146 0	148 6	144 6	—	—
Australian	151 6	148 0	151 0	148 0	155 6	149 6
New Zealand	154 0	151 6	154 6	151 6	158 6	152 6
Argentine	150 0	146 0	149 0	146 0	151 6	144 6
CHEESE :—						
British—						
Cheddar	101 6	95 6	103 0	100 6	103 0	97 0
			120 lb.	120 lb.	120 lb.	120 lb.
Cheshire	—	—	113 6	109 6	117 6	109 0
			per cwt.	per cwt.	per cwt.	per cwt.
Canadian	97 6	95 0	98 0	94 6	99 0	96 6
BACON :—						
Irish (Green)	105 0	98 0	103 6	99 6	106 0	100 6
Canadian (Green sides)	91 0	86 6	91 0	87 0	93 0	88 0
HAMS:—						
York (Dried or Smoked)	150 0	142 0	—	—	148 0	139 0
Irish (Dried or Smoked)	—	—	—	—	143 0	137 0
American (Green) (long cut)	90 0	88 0	92 0	87 6	91 0	87 6
EGGS :—	per 120.	per 120.	per 120.	per 120.	per 120.	per 120.
British...	19 4	—	—	—	22 6	21 0
Irish	20 10	—	21 7	20 1	21 4	20 0
American	16 2	—	15 7	14 9	16 7	15 7
POTATOES :—	per ton.	per ton.	per ton.	per ton.	per ton.	per ton.
British Queen ...	100 0	85 0	—	—	110 0	100 0
Edward VII.	116 0	105 0	80 0	76 6	106 6	100 0
Up-to-date	101 0	90 0	75 0	70 0	106 0	96 6
HAY:—						
Clover...	—	—	170 0	130 0	137 6	130 0
Meadow	—	—	—	—	133 0	124 6

AVERAGE PRICES of **British Corn** per Quarter of 8 Imperial Bushels, computed from the Returns received under the Corn Returns Act, 1882, in each Week in 1914, 1915 and 1916.

Weeks ended (*in* 1916).	WHEAT.						BARLEY.						OATS.					
	1914.		1915.		1916.		1914.		1915.		1916.		1914.		1915.		1916.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Jan. 8 ...	30	11	46	2	55	8	25	11	29	7	47	8	18	4	26	5	31	5
,, 15 ...	31	0	48	9	56	7	26	0	30	5	48	6	18	6	27	6	31	11
,, 22 ...	30	11	51	6	57	2	26	3	31	3	49	6	18	11	28	10	32	6
,, 29 ...	31	1	52	8	58	0	26	6	32	5	51	0	19	1	29	10	32	11
Feb. 5 ...	31	0	53	3	58	3	26	7	33	7	52	5	18	9	30	3	32	4
,, 12 ...	31	0	54	8			26	7	34	7			18	11	31	1		
,, 19 ...	31	0	56	0			26	7	34	11			18	11	31	5		
,, 26 ...	31	0	56	0			26	6	35	3			18	11	31	8		
Mar. 4 ...	31	5	55	11			26	2	34	6			18	9	31	8		
,, 11 ...	31	6	54	8			26	0	33	5			18	7	31	0		
,, 18 ...	31	5	53	9			25	8	32	2			18	6	30	7		
,, 25 ...	31	4	54	3			25	7	31	11			18	8	30	6		
Apl. 1 ...	31	6	54	6			25	6	31	9			18	5	30	6		
,, 8 ...	31	5	54	9			26	8	31	3			18	4	30	4		
,, 15 ...	31	7	55	4			25	4	30	10			18	4	30	5		
,, 22 ...	31	9	56	5			26	6	31	5			18	5	30	11		
,, 29 ...	31	9	58	3			26	0	32	7			18	5	31	5		
May 6 ...	32	2	60	5			25	6	33	3			18	9	32	4		
,, 13 ...	32	7	61	7			26	3	34	0			18	11	32	5		
,, 20 ...	33	0	62	0			25	10	34	1			19	0	32	8		
,, 27 ...	33	9	61	11			26	1	34	8			19	4	32	7		
June 3 ...	34	0	61	9			25	11	35	4			19	4	32	5		
,, 10 ...	34	1	60	1			24	11	34	5			19	8	32	4		
,, 17 ...	34	1	56	1			25	10	34	3			19	9	31	9		
,, 24 ...	34	3	52	0			25	4	34	4			20	0	31	9		
July 1 ...	34	4	49	5			24	6	35	3			19	9	31	1		
,, 8 ...	34	2	50	1			24	9	34	7			20	0	31	6		
,, 15 ...	34	1	52	7			24	2	35	8			19	10	31	6		
,, 22 ...	34	0	53	10			24	7	35	10			19	9	32	1		
,, 29 ...	34	2	55	3			25	9	36	1			19	8	31	1		
Aug. 5 ...	34	9	55	4			25	2	35	7			19	1	31	5		
,, 12 ...	40	3	55	2			29	4	37	0			25	1	31	7		
,, 19 ...	38	9	54	3			29	10	39	4			24	3	31	4		
,, 26 ...	36	2	51	11			30	3	38	3			23	5	30	0		
Sept. 2 ...	36	5	45	3			30	6	38	1			23	9	26	10		
,, 9 ...	37	10	43	0			29	11	37	11			23	11	26	8		
,, 16 ...	38	3	42	9			29	5	39	0			23	8	26	4		
,, 23 ...	37	6	43	3			29	3	39	8			23	3	26	1		
,, 30 ...	37	1	43	5			29	1	40	4			22	9	26	5		
Oct. 7 ...	36	8	44	1			28	10	41	0			22	5	26	5		
,, 14 ...	36	7	45	9			28	8	42	3			22	4	27	1		
,, 21 ...	37	2	48	2			28	7	44	0			22	5	28	1		
,, 28 ...	37	10	50	3			28	3	46	2			23	7	29	1		
Nov. 4 ...	38	8	51	6			28	6	47	3			23	7	30	4		
,, 11 ...	39	8	52	8			29	0	47	5			24	8	30	11		
,, 18 ...	41	0	53	6			29	8	47	11			25	5	31	3		
,, 25 ...	41	11	54	2			30	3	48	7			25	8	31	1		
Dec. 2 ...	42	2	53	7			30	2	48	11			25	9	30	11		
,, 9 ...	42	1	52	10			29	11	47	10			25	9	30	4		
,, 16 ...	42	7	53	11			29	8	47	5			25	9	30	6		
,, 23 ...	43	3	53	10			29	9	47	2			25	11	30	7		
,, 30 ...	44	4	54	9			29	10	47	5			26	6	30	10		

NOTE. Returns of purchases by weight or weighed measure are converted to Imperial Bushels at the following rates: Wheat, 60 lb.; Barley, 50 lb.; Oats 39 lb. per Imperial Bushel.

AVERAGE PRICES of **British Wheat, Barley,** and **Oats** at certain Markets during the Month of January, 1914, 1915, and 1916.

	WHEAT.			BARLEY.			OATS.		
	1914.	1915.	1916.	1914.	1915.	1916.	1914.	1915.	1916.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
London ...	32 2	51 0	58 2	27 6	32 6	47 0	20 3	29 11	33 3
Norwich ...	30 7	47 6	55 6	25 2	30 2	48 6	18 2	28 0	32 7
Peterborough ...	30 6	49 4	56 6	25 8	30 11	48 3	18 5	28 7	32 2
Lincoln ...	31 4	49 5	57 3	26 7	30 3	49 8	19 2	27 6	31 9
Doncaster ...	31 1	49 1	57 4	24 9	30 0	49 3	18 4	27 2	31 8
Salisbury ...	30 4	48 11	56 6	26 3	31 1	50 2	19 0	29 0	33 2

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